VOLUME 51
No. 4

WHOLE NO. 230
1939

Psychological Monographs

EDITED BY
JOHN F. DASHIELL
UNIVERSITY OF NORTH CAROLINA

Principles of Conditioning in Human Goal Behavior

By

ANTHONY J. MITRANO, Ph.D.
Child Study Department, Board of Education, Rochester, N. Y.

A DISSERTATION
PRESENTED TO THE FACULTY OF
THE GRADUATE SCHOOL OF YALE UNIVERSITY
IN PARTIAL FULFILLMENT FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

PUBLISHED BY
THE AMERICAN PSYCHOLOGICAL ASSOCIATION, INC.
PUBLICATIONS OFFICE
THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO

ACKNOWLEDGMENTS

This investigation was conducted under the guidance of Professor Clark L. Hull of the Institute of Human Relations, Yale University, to whom the writer is indebted in many ways. The study, which was carried on during the year 1935–36, was part of a coördinated research program of the Hull Unit. The nature of the study was considerably influenced by the suggestions of Professor Hull, and his generosity made it possible to construct the apparatus, most of which was made by his assistants. The experimentation was begun at The Training School at Vineland, New Jersey, and then transferred to the State Colony for Feebleminded Males at Woodbine, New Jersey. The project was facilitated by the coöperation of Professor Edward R. Johnstone, Director of The Training School, and Dr. Edgar A. Doll, Director of the Vineland Laboratory, to whom appreciation is gratefully expressed. Many thanks are also due to Dr. George Kreezer, formerly Research Associate at The Training School, for helpful suggestions, and to Mr. Edward L. Johnstone, Superintendent of the State Colony, who so cordially extended the facilities of his institution.

A. J. M.

CONTENTS

	PAGE
I. General Introduction	1
II. Generalization of Inhibition	13
III. Characteristics of Experimental Extinction in a Human Goal Situation	25
IV. Spontaneous Recovery	43
V. Curves of Satiation in Human Subjects	53
VI. Summary	63
VII. Bibliography	65

I. GENERAL INTRODUCTION

Since the publication of Pavlov's work on conditioning some psychologists have inferred that the Pavlovian principles of conditioning were also operative with human beings. On the other hand, a considerable number of psychologists have repeatedly asked, "But are the Pavlovian conditioning principles really operative with human beings?" These psychologists have consistently and rightfully maintained that in the absence of experimental evidence with human beings, no conclusions concerning the applicability of conditioning principles to human beings had been demonstrated.

During the past few years the work of Bass and Hull (6), Switzer (112), Shipley (96), Hovland (33–35), and Rodnick (93), has supplied evidence to show that conditioning principles, displaying essentially the same characteristics as found by Pavlov, were operative with human beings in such reflex mechanisms as tactile sensitivity, lid reaction, and galvanic response. But in spite of their researches with human beings, their experimental situations remained analogous to those of Pavlov in that the subject played a "passive" rather than an "active" rôle. That is, the human subject, quite like Pavlov's dogs, was strapped or otherwise maintained in such a way that his movements and his behavior did not influence the presentation of the conditioned stimulus. The subjects were in a highly artificial situation. It was our desire to arrange a situation which was "active" or "dynamic" rather than "passive"—a situation wherein the subject would have relatively few locomotor restrictions and could control his own movements in reference to the goal. There is in psychology no term which fits this type of behavior and we have, therefore, called it *goal behavior*. The purpose of this investigation was to determine if conditioning principles were operative in human goal behavior.

The motivation selected was the "food urge," specifically

represented by the striving of the subject to secure a small piece of candy. All subjects employed in the study were mentally deficient.

Apparatus [1]

Two mechanisms were used. One machine, upon the insertion of marbles, yielded poker chips; the other machine, upon the insertion of poker chips, yielded chocolate candy.[2] We shall hereafter refer to the first mechanism as the *marble-chip machine* and to the second mechanism as the *chip-candy machine.*

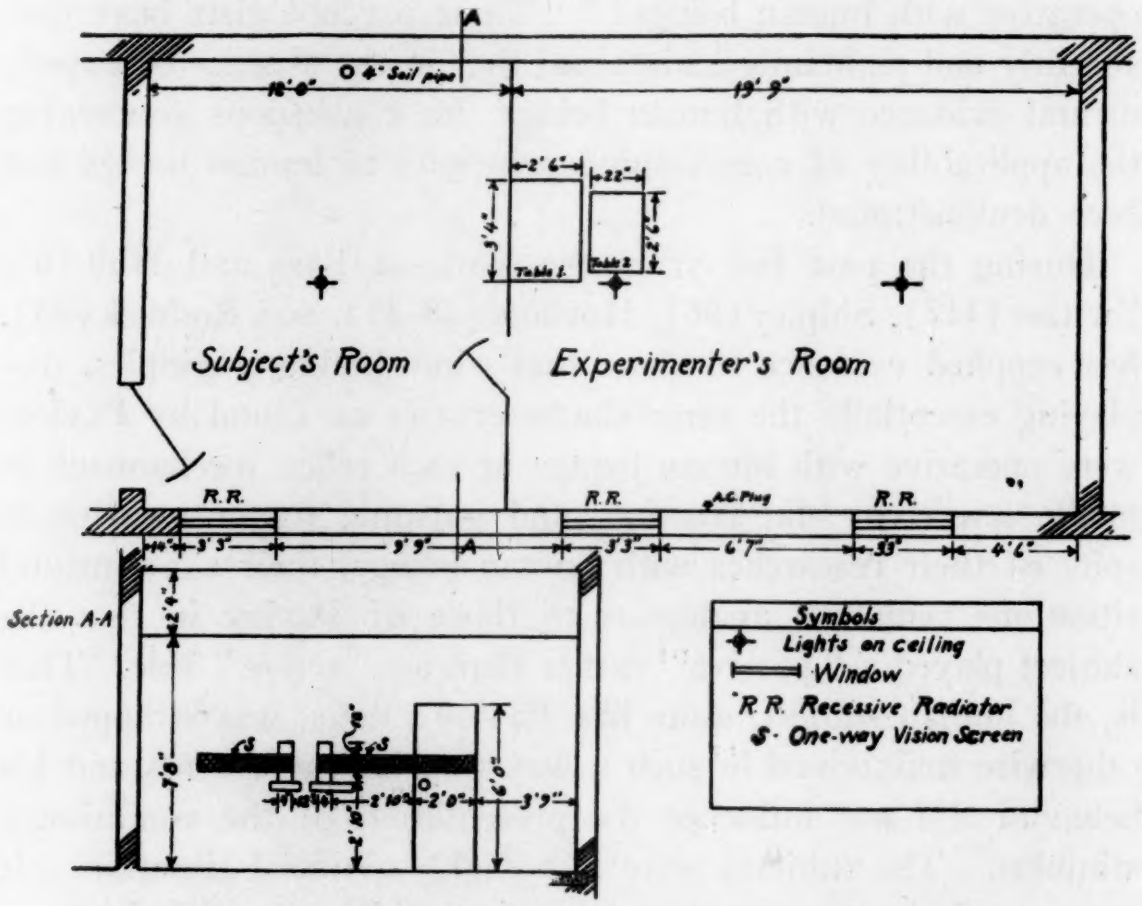

Figure 1. Floor Plan Drawing of Research Room

[1] The writer is indebted to Mr. Douglas G. Ellson and Mr. Paul G. Darling for aid in the construction of this apparatus. The writer also wishes to express his appreciation to the members of the Yerkes Laboratory at Yale for suggestions and criticism in reference to apparatus. It was in this laboratory that Dr. John B. Wolfe, from whom we have borrowed so freely, conducted his poker-chip experiments with chimpanzees (130).

[2] This candy, called "Nonpareil", is sold by the Woolworth chain of stores; the manufacturer is the Rockwood Candy Company of Bronx, N. Y. The one-half inch size, containing approximately ten calories, was used in the experiments. There were approximately 180 pieces to the pound.

Research Rooms. The room housing the apparatus is represented by the floor plan drawing, Figure 1. The research room was sectioned off by a brown press-board partition, ¼ inch in thickness, into a subject's room and an experimenter's room, both rooms having a common entrance. The marble-chip and chip-candy machines were set into this partition, as was also an adaptation of the Gesell one-way vision screen.

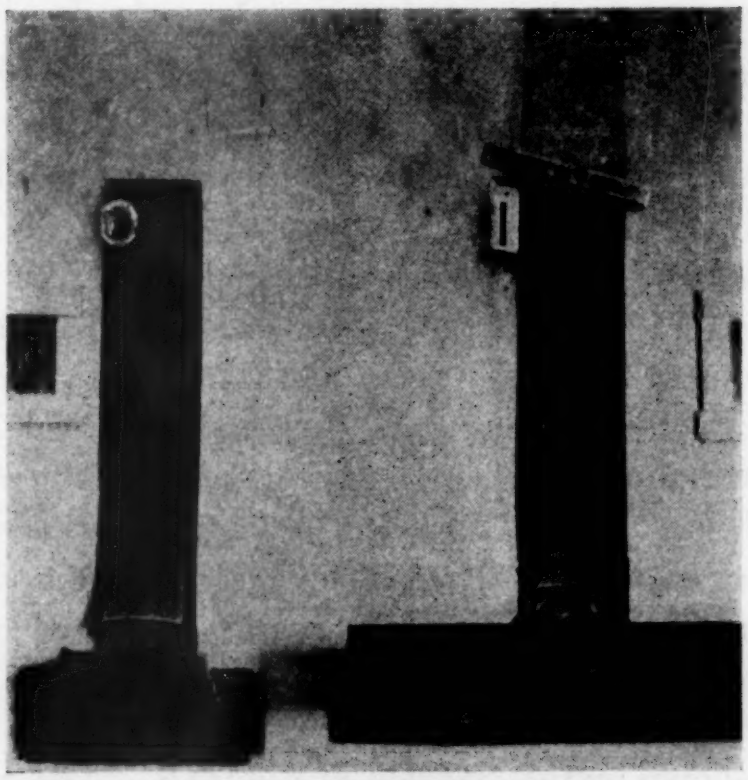

FIGURE 2. SUBJECT'S VIEW OF THE MARBLE-CHIP AND CHIP-CANDY MACHINES

The machine on the left is the marble-chip machine, the one on the right is the chip-candy machine. The marble slot is in the upper left-hand corner of the marble-chip machine; the chip slot is in the upper left-hand corner of the chip-candy machine. The steel bar above the chip slot was attached over the slot when the subject was to be prevented from inserting chips into the chip-candy machine. The chute of each mechanism was so constructed that the subject could not peer up into the machines. To the left of the marble-chip machine and to the right of the chip-candy machine may be seen portions of the one-way vision screen.

Subject's Room. The floor plan of the subject's room shows a number of characteristics related to the carrying out of the experiment (Fig. 1). There was a window in this room three feet from the floor; a recessive radiator was beneath the window and inaccessible to the subject; a switch with a 100-watt,

110-volt lamp provided the overhead lighting. A chair, not shown in the diagram, was always set in the middle of the room. The chair was placed in the room not only to provide a means of comfort to the subject but used also as the surface upon which marbles and chips were placed.

The subject's view of the apparatus is shown by the section A-A drawing of Figure 1 and also by the photograph, Figure 2. It will be noticed (Fig. 2) that the machines were placed beside each other and that the marble-chip machine was to the left of the chip-candy machine. They were placed one foot apart and were almost identical in shape and color. Both were painted a dull black and contrasted with the brown surroundings of the press-board partition.

Experimenter's Room. The experimenter's room (floor plan diagram, Fig. 1) was larger than that of the subject. The essential items of interest in this room were: table 1 which served as a base for the vending machines and electrical accessories; table 2 which supported the recording polygraph; two overhead lights which were always turned off during experimentation; and two windows which were covered by green shades. The absence of light in the experimenter's room facilitated observation through the one-way vision screen.

Chip-Candy Machine. The rear view of the chip-candy machine is shown by the diagram in Figure 3. The machine was bolted to the table and nailed to the partition It was constructed of white pine, and measured 28 inches in height and 14 inches in inside width. The sheet-metal shelves (h) of the mechanism, 60 in number and each $1\frac{1}{2}$ inches by $1\frac{1}{2}$ inches by $\frac{1}{16}$ inch thick, were riveted $\frac{1}{2}$ inch apart on a leather belt (f) which measured 30 inches by $\frac{1}{5}$ inch by $\frac{1}{8}$ inch thick. The belt revolved around two ball-bearing pulleys (c) and (c′), placed in a vertical plane. The distance between the two pulleys could be varied by a screw arrangement (a) at the top of the hanger (b) which supported the axle of the upper pulley. The shelves were prevented from falling by a copper extension (k) soldered to the arm of the relay (l); the relay was used for its mechanical action in withdrawing the arm to which the copper extension was

soldered. The moving force acting on the belt was provided by the dropping of a four-pound weight (g) attached by means of

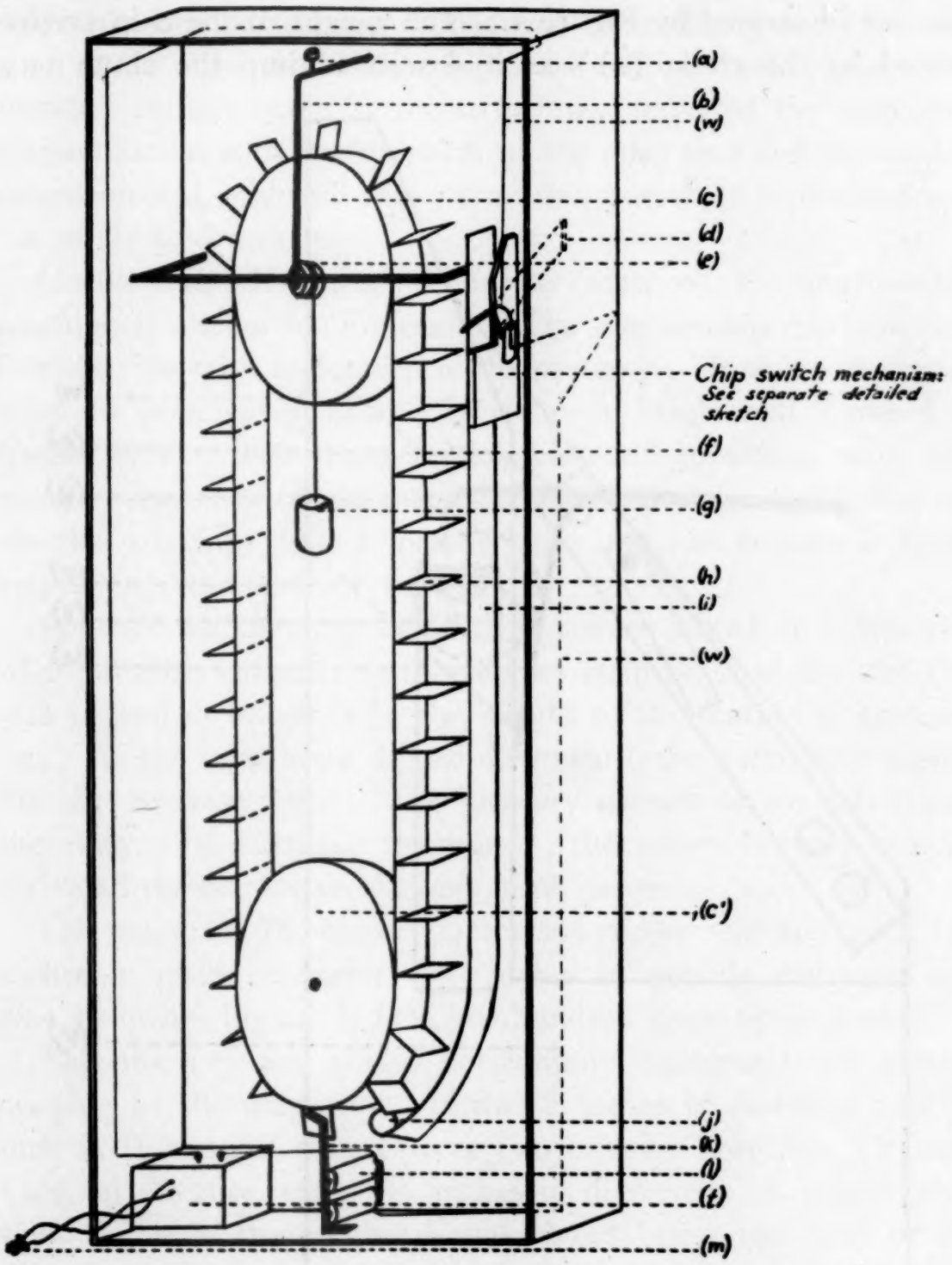

FIGURE 3. REAR VIEW OF CHIP-CANDY MACHINE

a fish line to a wooden spool (e) which was fastened to the axle of the upper pulley. The chute is represented by the space wherein the candy (j) is shown; (i) is a sheet of galvanized

iron which prevented the candy from dropping out; (t) represents the step-down transformer.

The candy was discharged from the chip-candy machine in the manner illustrated by Figure 4. The weight of the chip (represented by the circle (s)) as it descended into the chute (n),

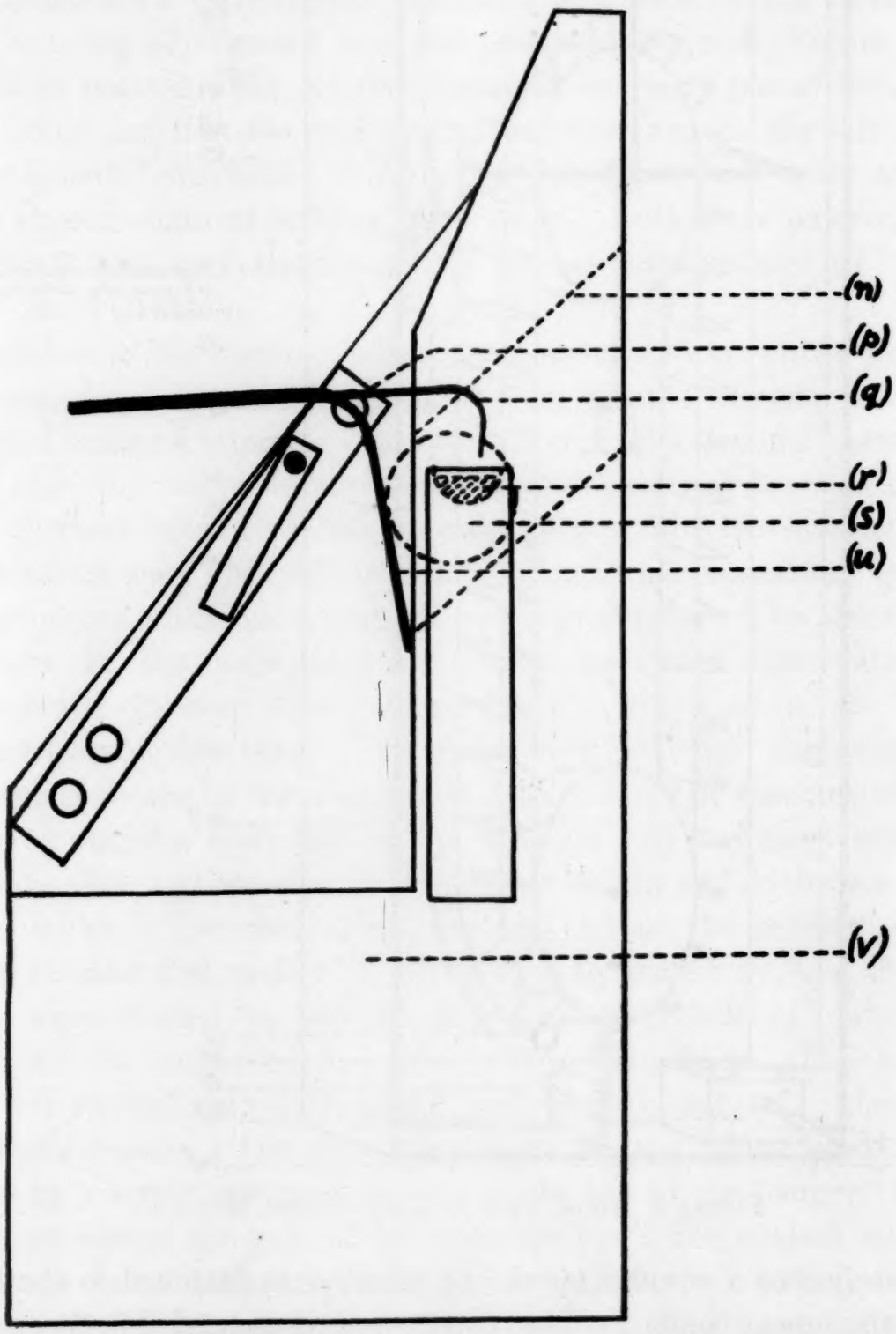

FIGURE 4. SLOT MECHANISM OF CHIP-CANDY MACHINE

forced upward a piece of strip brass (u) which blocked the passage. As the strip brass extended upward by means of pivot (p) during the passage of the chip, a piece of wire (q) soldered to the strip brass dipped into the mercury cup (r). As soon as the chip passed, the strip brass fell back into place. The mercury contact made by the strip brass activated the relay; the magnetization withdrew the arm of the relay to which the copper extension was soldered, thus permitting one shelf to descend and the candy to drop out.

Marble-Chip Machine. The rear view of the marble-chip machine is shown by Figure 5. The marble-chip machine was bolted to the table and nailed to the partition. It was constructed of white pine and measured 21 inches in height and 9 inches in inside width. The items in this piece of apparatus were two mercury switches (c), a magazine for chips (d), a disc for the ejection of chips (e), a locking relay (i), an automatic break switch (f), and a motor (j).

The two mercury-cup switches (c) were placed on either side of the marble chute (a). A piece of strip brass in the slot (b) was pushed downwards by the weight of the marble in descending. As the strip brass dipped downward, the extensions dipped into the mercury cups. The mercury contact to the left closed the relay and activated the motor; the other mercury contact activated the marker on the polygraph paper.

The magazine for chips (d) was of copper and measured 1⅝ inches in inside diameter, 1⅞ inches in outside diameter, and was 13 inches high. It held one hundred chips when loaded.

The disc (e) was placed horizontally underneath the bottom opening of the magazine. It was 5 inches in diameter and ½ inch in thickness. There were two circular openings, (k) and (k′), in the disc, each 1¾ inches in diameter. A copper plate (not visible in the diagram) was placed below that part of the disc (e) which was underneath the bottom opening of the magazine; the chute (g) was placed beneath the other part of the disc. The circular openings in the disc were the means by which the chips were carried from the magazine to the chute where, since no support underlay the opening of the disc, the chip was dropped.

As one circular opening dropped a chip, the other opening was thrown in place underneath the magazine and was provided with another chip. The center of the disc was attached to the shaft (1) of the motor by which it was propelled.

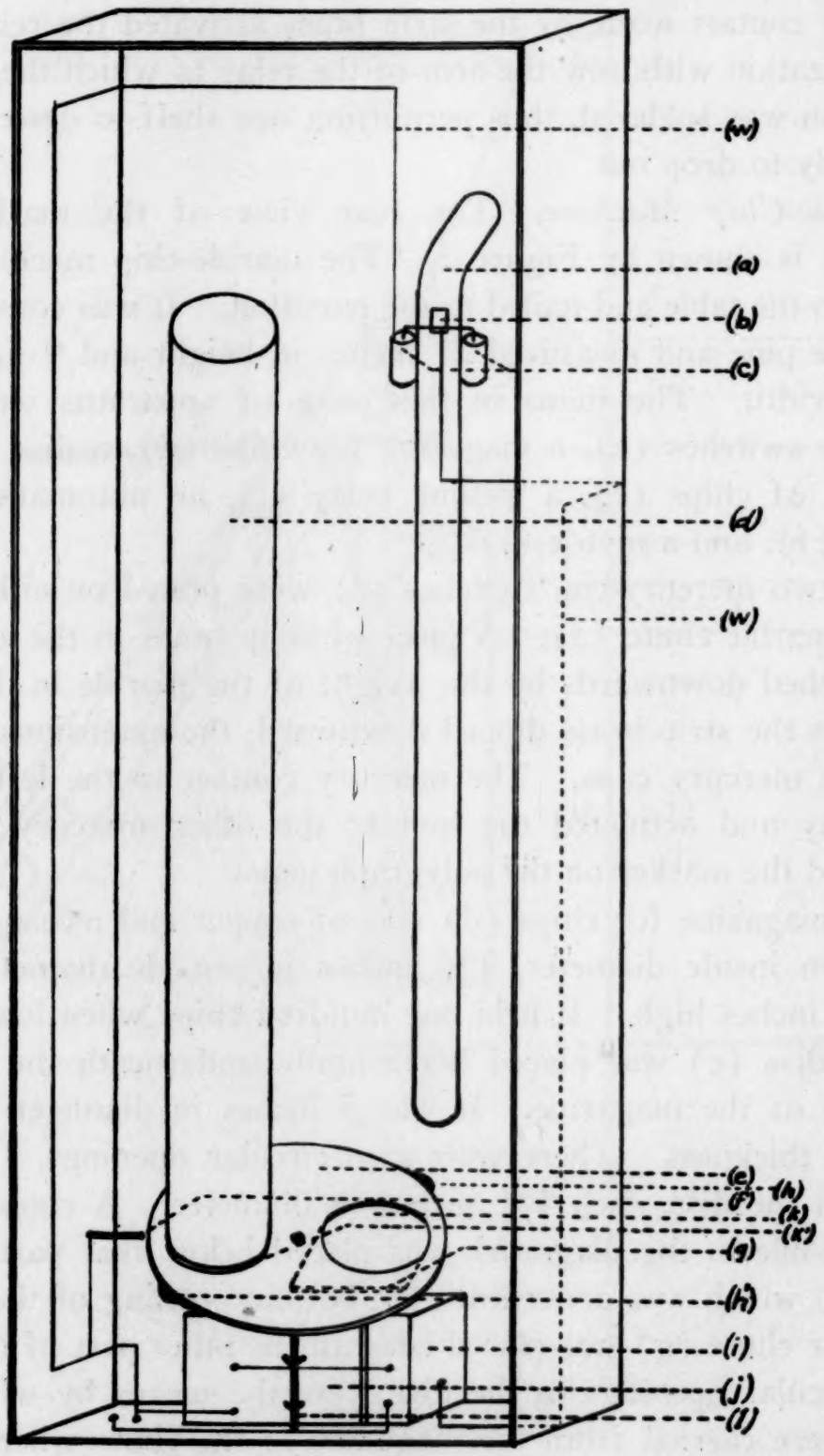

FIGURE 5. REAR VIEW OF MARBLE-CHIP MACHINE

Since the mercury contact brought about the permanent magnetization of the locking relay (i), it was necessary to provide some means of shutting off the current. This was done in the following manner: Two small lead abutments (h) and (h′) were soldered to the rim of the disc, opposite to each other and each extending out ⅜ of an inch. A piece of spring brass (f), in mechanical contact with a wire and forming a closed circuit with the locking relay, was placed ⅛ inch from the rim of the disc. This constituted the automatic break switch. The revolution of the disc was stopped when one of the lead abutments on the revolving disc struck the spring brass and broke the spring brass-wire contact, thus opening the circuit to the locking relay. The release of the locking relay automatically shut off the current to the motor. Since there were two abutments, a one-half revolution of the disc ejected one chip.

Recording Mechanisms. The recording mechanism was a polygraph carrying 6-inch waxed paper through two 8-inch typewriter rollers, each 1¼ inches in diameter. The polygraph was operated by a synchronous motor to which the rollers were attached by means of a shaft and worm-gear arrangement. The polygraph is the type in common use at the Yale Laboratories of Psychology.

The four markers used were adapted from ordinary buzzers; a thin piece of strip brass soldered to one of the magnets of the buzzer provided the means by which the surface of the waxed paper was scratched whenever the marker was activated. A dry cell in series with the buzzer provided the source of current.

The insertion of a marble into the marble-chip machine closed a mercury switch (Fig. 5, (c)) which activated the marker for the mechanism. The marker for the chip-candy machine was operated when the relay (Fig. 3, (l)) was closed. The mechanical action brought about by the magnetization of this relay not only permitted a shelf to drop (Fig. 3) but also closed a contact of two extension electrodes, thus recording the reaction of the subject.

Selection of Subjects and Procedure

Selection of Subjects. The best mental age for experimental purposes was found to be between two and five years. A subject with a mental age of two and a half years and a life age of about eight is, perhaps, ideal. Hydrocephalic, microcephalic, macrocephalic, birth-injured, and other individuals of special clinical types were not used. The only exception to this rule was the use of mongolians. Our subjects are, then, what the clinical psychologist labels the "no special clinical type" of mental deficiency. Strictly homogeneous groups could not be obtained, but for each subject in the experimental group there was always a fairly equivalent subject in the control group. The groups of subjects were equated on the bases of mental age and life age and also, as far as possible, according to weight and general body build. Males only were used.

The experimenter always conducted the subject to the bathroom before beginning the experiment. If the subject defecated or urinated during the experiment his record was discarded.

Procedure. The experimenter himself would get the subject from the cottage and obtain *rapport* with him while on the way to the laboratory. Praise, either verbally or by gestures, was almost always effective in establishing friendship. Sometimes a subject was fearful, apprehensive, or stubborn. Under such circumstances he was not used. The subject was always experimented on two hours after the last meal; two subjects were used each day.

After reaching the laboratory the subject was seated in a comfortable chair in a reception room just outside the actual rooms used for experimental purposes. The experimenter would then check the apparatus. When the subject was conducted into the experimental room he was asked to help close and lock the door, in order to dispel any fear the subject might have that he was being locked in. Following this the experimenter would instruct the subject in the manner of getting candy. Instruction was always by means of gestures, never verbally. The experimenter would point to the marbles on the chair and to the slot of the

marble-chip machine. After the subject had succeeded in getting the chip, the experimenter would point to the chip and to the slot of the chip-candy machine. Little or no encouragement was needed to suggest that the candy should be eaten. One demonstration sufficed in the majority of cases to establish the behavior sequence. As soon as the subject began performing the act in its proper sequence, the experimenter disappeared behind the partition and observed him through the one-way vision screen.

II. GENERALIZATION OF INHIBITION

According to Pavlov:

". . . experimental extinction of any single conditioned reflex results, not only in a weakening of that particular conditioned reflex which is directly subjected to the extinction . . . but also in a weakening of other conditioned reflexes which were not directly subjected to extinction . . ." (80, 54).

This tendency for other conditioned reflexes to be affected by extinction is what Pavlov means by generalization of inhibition. In addition to Pavlov, a number of other workers have gathered data on generalization of inhibition, notably, Anrep (5), Bass and Hull (6), Hovland (34–35), Rodnick (93), and Shipley (95–96). In all these cases restricted physiological mechanisms were studied. *Since the principle of generalization of inhibition has been used to explain behavioral adjustment of the total organism, its operation at this level of behavior is in need of demonstration. This paper presents the results of an experiment on generalization of inhibition with human subjects in a goal situation.*

The primary problem of this investigation will be illustrated by the use of a diagram. Let

$$\text{Ru}\overset{1}{—}\text{Rv}—\text{Rw}\overset{2}{—}\text{Rx}$$

represent a behavior sequence. Let Ru, Rv, and Rw represent behavior segments leading to the final successful or consummatory response, Rx. Let the digits 1 and 2 represent points at which the behavior sequence may be interrupted, frustrated, or extinguished. The following questions may then be raised: First, will the extinction of the sequence at point 2 facilitate the subsequent extinction of the sequence at point 1? Second, will the extinction of the sequence at point 1 facilitate the extinction of the sequence at point 2?

What deductions can be made from established principles which will help us predict the outcome of the experiment? One principle applicable to this situation is the "goal-gradient hypothesis" formulated by Hull (41, 45). "The substance of

this hypothesis is that reactions taking place in close proximity to the goal get conditioned to the stimuli preceding them more strongly than anywhere else in the behavior series, and that other reactions in the series are conditioned to the stimuli preceding them with progressively less strength the more remote (in time or space) they are from the goal" (45, 393). If the hypothesis holds in this situation then the behavior sequence should be more strongly conditioned at point 2 than at point 1, and point 2 should therefore be more resistant to experimental extinction.

A conditioning principle of Pavlov combined with the goal-gradient hypothesis of Hull permits us to predict other results of the experiment. According to Pavlov, the extinction of a strong conditioned reaction will abolish completely, generally speaking, a weaker conditioned reaction, whereas the extinction of a weaker conditioned reaction only partially affects the strong conditioned reaction (80, 56). This principle, taken in conjunction with the goal-gradient hypothesis, leads to the inference that extinction at point 2 should have a relatively great inhibitive effect upon point 1; but extinction at point 1, on the other hand, should show little or no inhibitive effect upon point 2. This assumes that the results of Pavlov hold for the goal situation.

The plan of the present study was to set up a behavior sequence of the type indicated by the diagram on page 13 and observe whether the theoretical expectations are realized.

Apparatus and Procedure

The apparatus employed in this study has been described in detail in the General Introduction. There were two mechanisms: a machine which yielded poker chips upon the insertion of marbles, and a machine which yielded chocolate candy upon the insertion of poker chips. During the period in which the behavior sequence was being established, both machines were present. The subject got a marble from a near-by chair, put the marble into the marble-chip machine, got a poker chip, put the chip into the chip-candy machine, and finally obtained the candy and ate it. The application of the diagram on page 13 to this experimental situation may be made if we let Ru=inserting a

marble into the marble-chip machine; Rv=getting a chip; Rw=inserting the chip into the chip-candy machine; and Rx=getting the candy and eating it.

Once this behavior sequence had been established, steps were taken to extinguish certain links in the chain. Extinction at point 1 was brought about in this way: the marble-chip machine was loaded with marbles rather than chips so that the subject upon inserting a marble into the marble-chip machine received another marble instead of a chip in return. Extinction at point 2 was brought about by the fact that the chip-candy machine was loaded with chips rather than candy so that when the subject inserted a chip into the machine he received another chip instead of candy in return. The subject was at liberty to continue inserting chips (or marbles) as long as he wished; the extinction criterion was met when he failed to insert a chip (or marble) for a period of five minutes. During extinction only one machine was present at a time. Closely following extinction on one machine, extinction was carried out on the other machine.

The detailed procedure of the experiment was as follows: The subject was conducted into the experimental room and permitted to complete the behavior sequence ten times; that is, to receive ten reinforcements (ten pieces of candy) in running through the following behavior sequence. He first put a marble into the marble-chip machine and received a chip; he then put the chip into the chip-candy machine and received a piece of candy. The behavior sequence was regarded as complete when the subject had eaten the candy. The subject was not allowed to repeat the sequence until the piece of candy obtained had been eaten. After the ten reinforcements had been obtained, the subject was led into an adjoining room where he remained for three minutes while the experimenter removed one of the machines. He was brought back into the experimental room and extinguished at the point in question. He was again led into the adjoining room and again remained for three minutes.[3] Meanwhile the experi-

[3] The greater the time interval between periods of successive extinction, the less will generalization of inhibition manifest itself (**80**, 159). The short interval of three minutes was adopted in order to avoid too much spontaneous recovery.

menter replaced one machine with the other. The subject was brought back into the experimental room and the second point in question was extinguished. If the subject did not react for a period of five minutes after entrance into the room, the trial was recorded as zero.

Two groups of 16 subjects each were employed, each group serving as a control for the other. All the subjects were low-grade mentally deficient male children from the State Colony at Woodbine, New Jersey. The subjects were equated, so far as possible, on the bases of mental age and life age. Table 1 shows how the groups compared with respect to Binet mental ages and life ages. Group A was extinguished first at point 2 and then at point 1; Group B was extinguished first at point 1 and then at point 2.

TABLE 1

CHARACTERISTICS OF THE EXPERIMENTAL GROUPS WITH RESPECT TO BINET MENTAL AGE (MA) AND LIFE AGE (LA)

	Group A		Group B	
	MA	LA	MA	LA
M	2.8	10.4	2.9	10.8
σ	.7	1.9	.6	2.0
$\sigma_{av.}$	.18	.48	.15	.50
Range	1.1–4.0	6.7–12.8	2.0–4.1	6.3–13.4

RESULTS

A. *Differences between first extinction and second extinction:*

The mean number of responses and the mean extinction time decreased during the second extinction. The means and the critical ratios ($M_1-M_2/\sigma_{diff.}$) are shown in Table 2.

TABLE 2

MEAN NUMBER OF RESPONSES, MEAN EXTINCTION TIME, AND THE CRITICAL RATIOS OF THE DIFFERENCES ($M_1-M_2/\sigma_{diff.}$) BETWEEN THE FIRST EXTINCTION AND THE SECOND EXTINCTION

Variable Measured	Group	Point 1		Point 2	Critical Ratio
Number of Responses	A	23	←	78	2.4
	B	91	→	72	1.0
Time for Extinction	A	523″	←	1355″	2.9
	B	1110″	→	635″	3.4

From Table 2 it is seen that for Group A the mean number of responses during the first extinction, 78, is greater than the mean number of responses during the second extinction, 23. For this same group the mean time required for the first extinction, 1355

TABLE 3

PERCENTAGE OF REDUCTION IN RESISTANCE TO EXPERIMENTAL EXTINCTION FROM POINT 2 TO POINT 1, WITH GROUP A USING NUMBER OF RESPONSES DURING EXTINCTION AS THE UNIT OF MEASURE

Subject	No. of Responses During Extinction at Point 2	No. of Responses During Subsequent Extinction at Point 1	Point 2—Point 1	$\frac{\text{Point 2—Point 1}}{\text{Point 1+Point 2}}$
1	122	8	114	.877
2	59	1	58	.967
3	166	14	152	.845
4	17	7	10	.417
5	34	17	17	.333
6	24	0	24	1.000
7	29	5	24	.705
8	75	73	2	.001
9	14	17	—3	—.097
10	7	8	—1	—.067
11	363	22	341	.886
12	1	0	1	1.000
13	171	172	—1	—.003
14	1	0	1	1.000
15	2	1	1	.333
16	156	16	140	.814
Mean	78	23	Mean 55	.563
σ	97	44	Median 13.5	.759
$\sigma_{av.}$	24	11		
Median	31.5	8		

r=.32
D/$\sigma_{diff.}$=2.4

Student's correction was employed since there were only sixteen cases.

seconds, is greater than the mean time required for the second extinction, 523 seconds. This is all quite in conformity with theoretical expectations. The critical ratio for responses=2.4; the critical ratio for time=2.9.

For Group B, the mean number of responses for the first extinction, 91, is greater than the mean number of responses for the second extinction, 72. Furthermore, the mean time for the

first extinction of Group B, 1110 seconds, is greater than the mean time for the second extinction, 635 seconds. This is also in conformity with expectation. The critical ratios for Group B are 1.0 for responses and 3.4 for time.

TABLE 4

PERCENTAGE OF REDUCTION IN RESISTANCE TO EXPERIMENTAL EXTINCTION FROM POINT 2 TO POINT 1 WITH GROUP A USING TIME FOR EXTINCTION, IN SECONDS, AS THE UNIT OF MEASURE

Subject	Time for Extinction at Point 2	Time for Subsequent Extinction at Point 1	Point 2—Point 1	$\frac{\text{Point 2—Point 1}}{\text{Point 1+Point 2}}$
1	1528	558	970	.465
2	656	/		
3	2617	320	2297	.782
4	711	189	522	.580
5	548	206	342	.454
6	616	(—)		
7	135	18	117	.764
8	1632	1836	—204	—.058
9	572	303	269	.307
10	162	72	90	.384
11	2760	454	2306	.717
12	/	(—)		
13	2456	1386	1070	.278
14	/	(—)		
15	30	/		
16	1782	412	1370	.624
Mean =	1355	523	Mean = 831.7	.482
σ =	983	570	Median = 522	.465
$\sigma_{av.}$ =	297	172		
Median =	1528	320		

r=.32
D/$\sigma_{diff.}$=2.9

/=Responded only once, therefore time not calculable.
(—)=Did not respond during extinction period, therefore time not calculable.

The time taken for extinction does not include the five minute criterion of experimental extinction. Since time is taken from the first to the last response, no time can be calculated where only one response was made. This also applies to Table 6.

B. *Degree of reduction in resistance to experimental extinction:*

In order to determine the degree of reduction in resistance to experimental extinction from the first extinction process to the

second extinction process the following method was employed: The number of responses during the second extinction was subtracted from the number of responses during the first extinction. This difference was then divided by the total of the number of responses during the first extinction plus the number of responses

TABLE 5

PERCENTAGE OF REDUCTION IN RESISTANCE TO EXPERIMENTAL EXTINCTION FROM POINT 1 TO POINT 2 WITH GROUP B USING NUMBER OF RESPONSES DURING EXTINCTION AS THE UNIT OF MEASURE

Subject	No. of Responses During Extinction at Point 1	No. of Responses During Subsequent Extinction at Point 2	Point 1—Point 2	$\frac{\text{Point 1—Point 2}}{\text{Point 1+Point 2}}$
1′	277	238	39	.077
2′	61	45	16	.150
3′	294	543	—249	—.297
4′	430	161	269	.455
5′	56	23	33	.417
6′	41	34	7	.093
7′	189	24	165	.774
8′	24	4	20	.714
9′	10	4	6	.428
10′	18	5	13	.565
11′	38	62	—24	—.240
12′	6	4	2	.200
13′	1	0	1	1.000
14′	4	5	—1	—.111
15′	7	4	3	.272
16′	4	2	2	.333
Mean	= 91	72	Mean = 18.87	.295
σ	= 132	116	Median = 6.5	.302
$\sigma_{av.}$	= 33	29		
Median	= 31	14		

$r=.82$
$D/\sigma_{diff.}=1.0$

during the second extinction. This yielded the degree (percentage) to which the second extinction process decreased. For example, in Table 3 we find that subject 1 responded 122 times during the first extinction and 8 times during the second extinction. The difference, 114, divided by the number of responses during the first extinction plus the number of responses during the second extinction, 130, yields .877 (87.7 per cent). This

simply means that the subject lost this much of the extinction resistance. In the case of those subjects who responded more during the second extinction process than during the first (or took a longer period of time for extinction) the difference ratio has a minus (—) sign before it. The percentage of decrease in terms of the mean and median is given in each table.

TABLE 6

PERCENTAGE OF REDUCTION IN RESISTANCE TO EXPERIMENTAL EXTINCTION FROM POINT 1 TO POINT 2 WITH GROUP B USING TIME FOR EXTINCTION, IN SECONDS, AS THE UNIT OF MEASURE

Subject	Time for Extinction at Point 1	Time for Subsequent Extinction at Point 2	Point 1—Point 2	$\frac{\text{Point 1—Point 2}}{\text{Point 1+Point 2}}$
1′	2172	1553	619	.166
2′	356	900	—544	—.433
3′	4551	3648	903	.110
4′	3900	1426	2474	.464
5′	233	102	131	.391
6′	418	309	109	.149
7′	1890	222	1668	.789
8′	906	13	893	.971
9′	162	81	81	.333
10′	176	24	152	.760
11′	1695	1161	534	.186
12′	90	42	48	.363
13′	/	(+)		
14′	18	24	—6	—.142
15′	36	15	21	.411
16′	44	9	35	.660
Mean	= 1110	635	Mean = 474.53	.345
σ	= 1460	1001	Median = 131	.363
$\sigma_{av.}$	= 378	259		
Median	= 356	102		

r=.97
$D/\sigma_{diff.}$=3.4

See footnote, Table 4.

(1) *Reduction in resistance to experimental extinction with Group A:*

It will be seen by reference to Table 3 that the median loss of extinction strength with Group A was 75.9 per cent when number of responses is used as the unit. When time is used as the unit (Table 4), the median loss of extinction strength is 46.5 per cent.

(2) *Reduction in resistance to experimental extinction with Group B:*

Table 5 shows that when number of responses is the unit of measure the median loss of extinction strength with Group B is 30.2 per cent. In Table 6 it will be seen that when time is used as the unit of measure the median loss of extinction strength is 36.3 per cent.

C. *Number of subjects in each group showing fewer responses and less time for extinction during the second extinction process:*

The problem of generalization of inhibition is one of decrement. Does the subject show a loss of extinction strength during the second extinction as the result of his previous extinction? We have already presented data to show that the average number of responses and the average time for extinction decrease during the second extinction (Table 2). The percentages of decrement have also been given in Tables 3, 4, 5, and 6. By resorting to the theory of probability of compound events, a third method is employed to show the reliability of the presence of a decrement.*

(1) *Group A:*

Inspection of Table 3 reveals that 13 of the 16 subjects showed fewer responses during the second extinction. Inspection of Table 4 reveals that 13 of the 16 subjects took less time for the second extinction. The probability of a chance occurrence for the results of Table 3 is but .0085. For Table 4, the chance probability is also .0085. When the results of both tables are combined the probability is .0002.

(2) *Group B:*

Thirteen of the 16 subjects in Table 5 and 13 of the 16 subjects in Table 6 gave fewer responses and less time for extinction during the second extinction. The chance probability of the

* For an exposition of the theory of the probability of compound events, see chapter seventeen of Thurstone, L. L., The Fundamentals of Statistics. New York: The Macmillan Co., 1928.

results of either table is .0085. If the results of the two tables are combined, the probability of a chance occurrence is .0002.

Discussion

A. *Deductions:*

Referring to our use of a diagram wherein

$$\overset{1}{\text{Ru}}\text{—}\text{Rv}\text{—}\overset{2}{\text{Rw}}\text{—}\text{Rx}$$

represents a behavior sequence, it is found that the breaking of the sequence at point 2 facilitates the breaking of the sequence at point 1, and that the breaking of the sequence at point 1 facilitates the breaking of the sequence at point 2. On page 13 it was stated that on the basis of the goal-gradient hypothesis of Hull in conjunction with a Pavlovian principle concerning the effects of extinction two deductions could be set up. First, on the basis of the goal-gradient hypothesis the behavior sequence should be more strongly conditioned at point 2 than at point 1 and, therefore, more resistant to extinction. Second, since point 2 can be assumed to be more strongly conditioned than point 1, it should follow, from Pavlov's principle,[4] that the extinction of point 2 would have a great inhibitive effect upon point 1 whereas the extinction of point 1 would show relatively little inhibitive effect upon point 2. Was such a state of affairs found? Since the second deduction includes the first, both deductions can be said to have been substantiated if the second is satisfied. The results[5] are summarized in Table 7.

TABLE 7

Reduction in Resistance to Experimental Extinction

Variable Measured	Direction	Loss of Extinction Strength
Number of Responses	from Point 2 to Point 1	75.9%
	from Point 1 to Point 2	30.2%
Time for Extinction	from Point 2 to Point 1	46.5%
	from Point 1 to Point 2	36.3%

[4] The extinction of a strong conditioned reaction will have a great inhibitive effect upon a weaker conditioned reaction whereas the extinction of a weaker conditioned reaction will have little inhibitive effect upon a strong conditioned reaction.

[5] The results are medians which were taken from Tables 3, 4, 5, and 6.

It is evident that whether number of responses or time is used as an index, reduction in resistance to experimental extinction is greater from point 2 to point 1 than from point 1 to point 2. The same tendency is observed when the means instead of the medians are taken as the basis of comparison. There is, of course, the possibility that the minor differences in the construction of the two mechanisms could have altered the results somewhat, but in the opinion of this experimenter such a likelihood is negligible. The two deductions previously outlined are therefore substantiated.

B. *Reference to Skinner's work:*

Our findings are germane to a conclusion reached by Skinner in one of his articles. He states that " . . . in a chain of reflexes not ultimately reinforced only the members actually elicited undergo extinction " (104, 237). In other words, generalization of inhibition does not take place. Skinner's conclusion was based upon an inspection analysis of typical curves of extinction; no statistical criteria were employed. On the basis of data in this investigation, Skinner's rule is in need of reformulation.

Conclusion

The experimental literature on generalization of inhibition, though not extensive, is decisive in showing that generalization of inhibition is an undeniable phenomenon in the usual conditioned-response study where physiological mechanisms are employed (5, 6, 34, 35). Although Wendt (125) has questioned the descriptive appropriateness of the term, the reality of the fact of generalization of inhibition has not been disproved. Recently Ellson (19) demonstrated the presence of generalization of inhibition with dogs in an experimental situation analogous to the one in this study. The present study, like Ellson's, is not of the usual conditioned-response type, but, none the less, generalization of inhibition was obtained. *It is important to emphasize that it was found operating in a motivated psychological situation in which the subject was permitted behavioral freedom.*

Aside from the actual experimental results, the significance of the present study inheres in its demonstration that the concepts of Pavlov can be used in attacking psychological problems in human goal behavior. It may be said that what we are here calling generalization of inhibition is nothing more than negative transfer of training. If so, it would be well to consider the need for re-evaluation of those postulates of learning which overlap the postulates of conditioning, in an attempt to determine those likely to bear more abundant experimental exploitation.

III. CHARACTERISTICS OF EXPERIMENTAL EXTINCTION IN A HUMAN GOAL SITUATION

Introduction

The work on experimental extinction has been done, for the most part, with conditioned reflexes. In addition to the researches of Pavlov and his associates, some of the more important studies are those of Hilgard and Marquis (30), Hovland (33), Hudgins (36), Kleitman and Crisler (55), Mikhaïloff (72), and Switzer (111). A few other relevant studies are those of Hilgard (23), Hilgard and Campbell (29), and Wendt (124). Hull has summarized much of this work (43). All these studies have been done with such neurophysiological mechanisms as salivation, the pupillary reflex to light, and the knee-jerk.

Hull (42), Hunter (49–52), Miller and Miles (74), Skinner (99, 101–104), and Youtz (135–136) have conducted investigations of extinction with white rats. In their experiments the animals were permitted locomotor freedom. Although on a different level of mammalian behavior, these experiments are analogous to the present study. Dr. Carl N. Rexroad has recently begun a series of experiments to show that the phenomena of conditioning are characteristic of human beings as well as of dogs and that "voluntary as well as reflexive acts are capable of being conditioned". For a preliminary report on this work see (91). Razran has pointed out that similar studies have previously been carried out (87).

In the traditional conditioned-reaction experiment the organism is passive in the sense that it cannot, because of behavioral restrictions, facilitate or hinder the presentation of the stimulus. In our studies the subject is in a situation wherein by responding to the stimulus, he initiates the next presentation of that stimulus. If the subject does not respond to the stimulus, further stimulations are not given. The subject is thus in control of the

experimental situation, relatively speaking. He can respond as often as he desires, and the number of presentations of the stimulus is an affair over which he exercises complete control. The situation is "active" rather than "passive"; the subject has relatively no behavioral restrictions and can control his own movements in reference to the goal. It is in these respects that our study differs from the usual conditioned-reaction investigation.

It would be desirable to compare the results of conditioning in the traditional condition-reaction experiments with those obtained from this study. But such a comparison could be only approximate. Nevertheless, we shall present our results and, with an eye to the limitations, compare them with the results of others.

Procedure

The data were obtained from 46 subjects who had not been used previously in studies of extinction. All the subjects were given the usual ten reinforcements and then subjected to extinction at point 2.[6] The conditions of extinction were the same except for slight differences which are outlined in Table 8.

In addition to these differences, the groups varied in respect to mental age and life age; see Table 9.

TABLE 8

Conditions of Extinction

Project 1 (8 subjects)	Project 2 (16 subjects)	Project 3 (22 subjects)
Both the marble-chip machine and chip-candy machine (on which extinction was carried out) were present during extinction.	Only the chip-candy machine (on which extinction was carried out) was present during extinction.	Same as for Project 1.
Following the ten reinforcements the subject was taken out of the room for five minutes previous to the beginning of extinction.	Following the ten reinforcements the subject was taken out of the room for three minutes previous to the beginning of extinction.	Following the ten reinforcements the subject was immediately started on extinction. He was not taken out of the room between the reinforcements and the extinction.

[6] For a consideration of the behavior sequence, see pages 13 to 15 of the section on Generalization of Inhibition.

TABLE 9

BINET MENTAL AGE AND LIFE AGE

	Mental Age		Life Age	
	Mean	$\sigma_{av.}$	Mean	$\sigma_{av.}$
Project 1	2.3	.11	9.7	.72
Project 2	2.8	.18	10.4	.48
Project 3	3.0	.21	15.1	.74

These differences did not appear to affect the general nature of the results. The results of the three groups are, nevertheless, presented independently.

RESULTS

The data are treated under the following categories:

A. Number of responses and time for extinction
   (1) As compared with other investigations
   (2) Correlations between responses and time for extinction
   (3) Correlations between mental age and responses, mental age and time, life age and responses, and life age and time

B. Rate of extinction
   (1) As a function of the interval between non-reinforced stimulations
   (2) Number of responses during first half of extinction time versus number of responses during second half of extinction time

C. Curve of extinction
   (1) Is it uniformly progressive?
   (2) Are there wave-like fluctuations?

D. Subjects' behavior during extinction

A. *Number of responses and time for extinction:*

(1) Table 10 gives the mean number of responses, mean time for extinction, and range for each group.

TABLE 10

MEAN NUMBER OF RESPONSES, MEAN TIME FOR EXTINCTION, AND RANGE FOR EACH GROUP

Groups	Number of Responses During Extinction			Time Taken for Extinction (in Seconds), Exclusive of the Five-Minute Criterion of Extinction		
	M	Range	$\sigma_{av.}$	M	Range	$\sigma_{av.}$
Project 1	71.1	4–149	19.7	941″	24″–2304″	278″
Project 2	77.6	1–363	23.9	1013″	0″–2760″[7]	236″
Project 3	134.6	2–799	52.8	1203″	10″–5372″	304″

[7] Since time for extinction was obtained by calculating the time between the first and the last response, time for extinction could not be computed where only one response was made.

Our results differ rather markedly from the usual conditioned-response study in respect to the mean number of responses or mean time for extinction and, also, in respect to the variability of responses. The mean number of responses, averaging the three groups, was 94 and the range was from 1 response to 799. Switzer, in his study of backward conditioning, obtained complete extinction with 1 to 8 presentations of the conditioned stimulus (**111**, 87–88). Hudgins got extinction with 3 to 8 presentations of the conditioned stimulus (**36**, 34). Both investigators substantiate Pavlov, who secured extinction with 5 to 10 presentations of the conditioned stimulus. It seems to be true, in spite of striking exceptions,[8] that extinction of a conditioned reflex in the traditional conditioned-response experiment is obtained rather readily, and that the range of extinction for responses or time is not so great as found in this study. It is interesting to note that Hunter, using white rats in a situation permitting behavioral freedom, obtained considerable ranges in extinctions. He presented the conditioned stimulus once every minute and found with one group of 41 rats that the range of extinction was from 16 to 164 minutes. With another group of white rats, the range of extinction was from 1 to 124 minutes (**51**, 142). Such findings are in agreement with those of this study. There is at present no satisfactory explanation for the variability of responses and the resistance to extinction in either Hunter's study or our own as contrasted with those of the traditional conditioned-response studies. There is the possibility that the greater degree of behavioral freedom permits the operation of disinhibitory factors, thus lengthening the course of extinction with some subjects. Irrespective of the differences between our results and those of the traditional conditioned-response studies, there is a very important point of agreement: *extinction is obtained in both instances.*

(2) In the course of the analysis of our data it appeared that those subjects who responded more often also took more time for extinction. In view of such a possibility, correlations

[8] For a list of experimenters who encountered resistance to experimental extinction, see Hilgard's article (**28**, 68).

between number of responses and time for extinction were computed for each group; these correlations are given in Table 11.

TABLE 11

PRODUCT-MOMENT CORRELATIONS BETWEEN NUMBER OF RESPONSES AND TIME FOR EXTINCTION

Group	r	PE_r
Project 1	.84	.070
Project 2	.90	.032
Project 3	.99	.003

The *r* is high enough in each group to warrant the statement that there is a positive relationship between number of responses and time for extinction. Such a finding suggests that either variable may be used to measure the strength of extinction. To our knowledge, such a relationship has not been presented heretofore.

(3) A number of other correlations are summarized in Table 12. These correlations between MA and responses, MA and time, LA and responses, and LA and time are all negligible. This would be expected from a conclusion of Hilgard who, in a review of the literature of conditioning, states that "There is no more a common factor of 'conditionability' than there is of 'learning'" (28, 70).

TABLE 12

PRODUCT-MOMENT CORRELATIONS BETWEEN BINET MENTAL AGE, LIFE AGE, AND RESPONSE AND TIME FOR EXTINCTION

Comparisons	Project 1		Project 2		Project 3	
	r	PE_r	r	PE_r	r	PE_r
Mental age vs. No. of responses for extinction	—.06	.24	—.01	.17	.27	.13
Mental age vs. Time taken for extinction	—.05	.24	.18	.16	.28	.13
Life age vs. No. of responses for extinction	.03	.24	.00	.17	.19	.14
Life age vs. Time taken for extinction	.05	.24	.02	.17	.28	.13

B. *Rate of extinction:*

(1) In pages 51 to 54 of his book *Conditioned Reflexes,* Pavlov enumerates the factors which affect the rate of experi-

mental extinction. We shall consider one of these factors in this section. Quoting from Pavlov, "Yet another important factor determining the rate of experimental extinction is the length of pause between successive repetitions of the stimulus without reinforcement. The shorter the pause, the more quickly will extinction of the reflex be obtained, and in most cases a smaller amount of repetitions will be required" (**80**, 52).

The question then arises in our experiment: Do those subjects who show the smallest time between stimulations also extinguish most rapidly? It is necessary to recall that the subjects in our study controlled the rate of presentation of the poker-chip stimulus. The time interval between successive presentations of the stimulus was, then, a matter of the subject's "volition", so to speak. Does the generalization of Pavlov hold in spite of this difference?

The subject's time for extinction, exclusive of the five-minute criterion, was divided by the number of responses during extinction, which gave the length of time between responses for each subject. The mean for each of the three groups was then determined.[9] In answering the question proposed in this section it is necessary to determine the relationship of the mean length of time between responses with the number of responses and with the time taken for extinction. If Pavlov's statement holds in our situation, then those subjects who had a large mean time between responses should show a shorter period of time for extinction and, also, fewer responses during extinction. It would be expected, therefore, that there should be a high degree of negative correlation between mean time between responses and the number of responses, and, also, a high degree of negative correlation between mean time between responses and time for extinction. The product-moment correlations are given in Table 13.

All the correlations are low, and since there is no correlation which is five times its PE, we cannot be certain of any real correlation. Nevertheless, all the correlations are negative and this

[9] The mean length of time between responses for the different groups was: 16″ for Project 1, 16″ for Project 2, and 23″ for Project 3. The differences between the means were not statistically significant.

strengthens the plausibility of Pavlov's generalization in regard to the relationship between the rate of extinction and the length of pause between successive presentations of the stimulus.[10] Though we cannot, on the basis of the present data, say with certainty that those subjects who show the smallest mean time between responses extinguish most rapidly, there is some indication of such a tendency.

TABLE 13

PRODUCT-MOMENT CORRELATIONS BETWEEN MEAN TIME FOR A RESPONSE VS. NUMBER OF RESPONSES FOR EXTINCTION AND ALSO MEAN TIME FOR A RESPONSE VS. TIME TAKEN FOR EXTINCTION [11]

Group Compared	r Mean Time for a Response vs. No. of Responses for Extinction	PE_r	r Mean Time for a Response vs. Time Taken for Extinction	PE_r
Project 1	—.33	.21	—.19	.23
Project 2	—.39	.14	—.25	.16
Project 3	—.51	.12	—.38	.14

(2) Pavlov states that extinction is progressive (**80**, 49). We take this to mean that rate, amplitude, frequency, and other characteristics decrease during the course of extinction. Pavlov, using the amount of salivary secretion as an index, has data to substantiate his conclusion (**80**, 49). Verification of his conclusion can be obtained from an examination of the data of Switzer (**111**), Hudgins (**36**), Hilgard and Marquis (**30**), Brogden and Culler (**8**), Skinner (**102**), Mikhaïloff (**72**), and others.

Does such a tendency also hold in the results of the present investigation? In this study, the rate of responding during extinction was determined. If the tendency of progressive decrement holds true in this situation, there should be more responses during the first half of extinction time than during the

[10] In a doctoral dissertation entitled "Temporal Factors in Experimental Extinction," Porter states that "The number of non-reinforced stimulations required to abolish the conditioned eyelid response was not found to be affected by varying the temporal interval between successive presentations" (**83**, i).

[11] Time taken for extinction was calculated in the customary manner, *i.e.*, not inclusive of the five-minute criterion of experimental extinction.

second half of extinction time.[12] This was true of 6 of the 8 subjects in Project 1, 14 of the 16 subjects in Project 2, and 18 of the 22 subjects in Project 3. In Project 1 the mean number of responses during the first half was 50, and during the second half, 21; in Project 2 the mean number of responses during the first half was 57, and during the second half, 20; in Project 3, the mean number of responses during the first half was 79, and during the second half, 56. The probability of a real difference was .98 for Project 1, .99 for Project 2, and .95 for Project 3.

C. *The curve of extinction:*

(1) The nature of the curve of experimental extinction has been treated by a number of writers, notably Finch and Culler (**20**), Hull (**43**, 437–440), and Skinner (**102**). Finch and Culler are of the opinion, on logical grounds, that a general curve of experimental extinction cannot be found because the extinction situation is dependent upon a number of different factors and no one curve of extinction can be called "typical", ". . . save as certain conditions of motivation are typical" (**20**, 659); further, ". . . the C–R is by no means a mere stereotype which automatically falls at a certain rate when the primary stimulus is omitted" (**20**, 659).

Previous to the publication by Finch and Culler, Hull, in a résumé of the literature on conditioning, stated that the work of the Russians, and that of Kleitman and Crisler (**55**), Switzer (**111, 112**), and Hudgins (**36**), ". . . reveal two fairly distinct types of curves" (**43**, 438). The most common, perhaps, is that reported by Switzer (**112**) in the form of a Vincent curve. "This type of curve usually shows a fairly steep fall at the beginning, which gradually approaches the horizontal as complete extinction is approximated" (**43**, 438). The second type of curve ". . . rises sharply at the outset for one or two stimulations after which it proceeds to fall rather steeply and then more gradually as it approaches zero" (**43**, 438). Examples of these types of curves are given by Hull (**43**, 437, 439) from the data of Switzer and Hudgins. Hull comments that ". . . as

[12] Extinction time is calculated from the first response to the last response.

yet the experimental conditions which bring about these two types of curve have not been determined" (**43**, 438). Since Hull's publication, Hovland (**35a**) has presented a convincing interpretation of some of the differences between the two types of curve.

In the light of the above statements, it will prove interesting to discover if our curves lend more support to one point of view than to another. Is extinction progressive?

In section B(2) of this study evidence was presented in substantiation of Pavlov's statement that extinction is "progressive". More responses were made during the first half of the extinction time than during the second half. We may now deal with the more detailed aspects of this progressive decrement in extinction by considering Figures 6 and 7. Both are composite graphs [13] of the extinction process. Since a five-minute criterion of extinction was used, we have plotted the curves both with and without the five-minute criterion of extinction.[14] Figure 6 is inclusive of the five-minute criterion whereas in Figure 7 the criterion time is omitted.[15] In these Vincent curves, the X axis is divided into ten equal units of time representing the time taken for extinction. Each point of the graph represents the ratio between the number of responses during that tenth of time as compared with the total number of responses. For example, during the first tenth of the extinction process in Figure 6, 23 per cent of the total number of responses was made.

If the curve without the five-minute criterion (Fig. 6) is compared with the curve with the five-minute criterion (Fig. 7), it is noted that the curve of extinction without the five-minute

[13] Curves showing the results of each of the different projects were plotted and are available in the thesis filed in the Yale Library. Since they showed no substantial differences from the composite curves only the composite curves are here given.

[14] In the opinion of the experimenter, the curve with the five-minute criterion of experimental extinction is more representative of the process as it took place, since the subjects were in the room during all this period of time.

[15] Subjects 11, 15, and 22 of Project 3 were not included in these composite graphs since these three subjects accounted for 76 per cent of the total number of responses. Statistically the exclusion is justified on the score that they are Huge Errors in the treatment of data.

criterion has a short upward deviation during the latter part of the extinction process. An analysis of the method of plotting the data revealed that the upward deviations may be regarded as artifacts, since the Vincent technique insures that all subjects

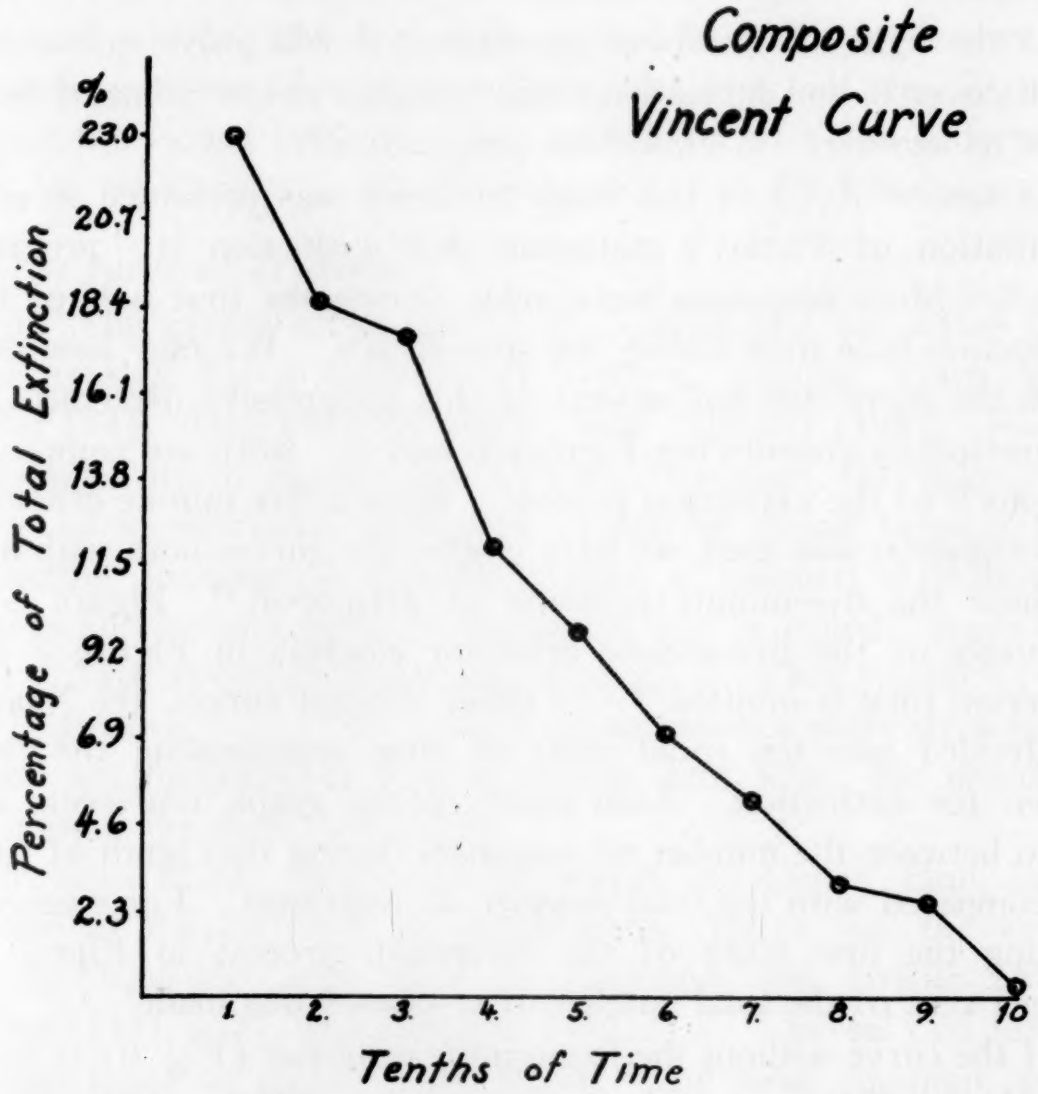

FIGURE 6. Composite Vincent curve of experimental extinction of Projects 1, 2, and 3, but exclusive of subjects 11, 15, and 22 of Project 3 who showed Huge Errors. The time, inclusive of the five-minute criterion, is plotted on the X axis. The values along the Y axis represent the percentages of the total number of responses made during each tenth of the extinction time. The curve is based upon a total of 2533 responses made by 43 subjects.

must have a reaction in the terminal section of the graph when the five-minute criterion is excluded.

If our curves of extinction are compared with the two types outlined by Hull, we find that none meets the requirements of the second type, *i.e.*, they do not rise " sharply at the outset for one

or two stimulations" and then "proceed to fall rather steeply and then more gradually" as zero is approached (43, 438). All of them may be said, however, to fall in the category of the first type of curve. "This type of curve," according to Hull,

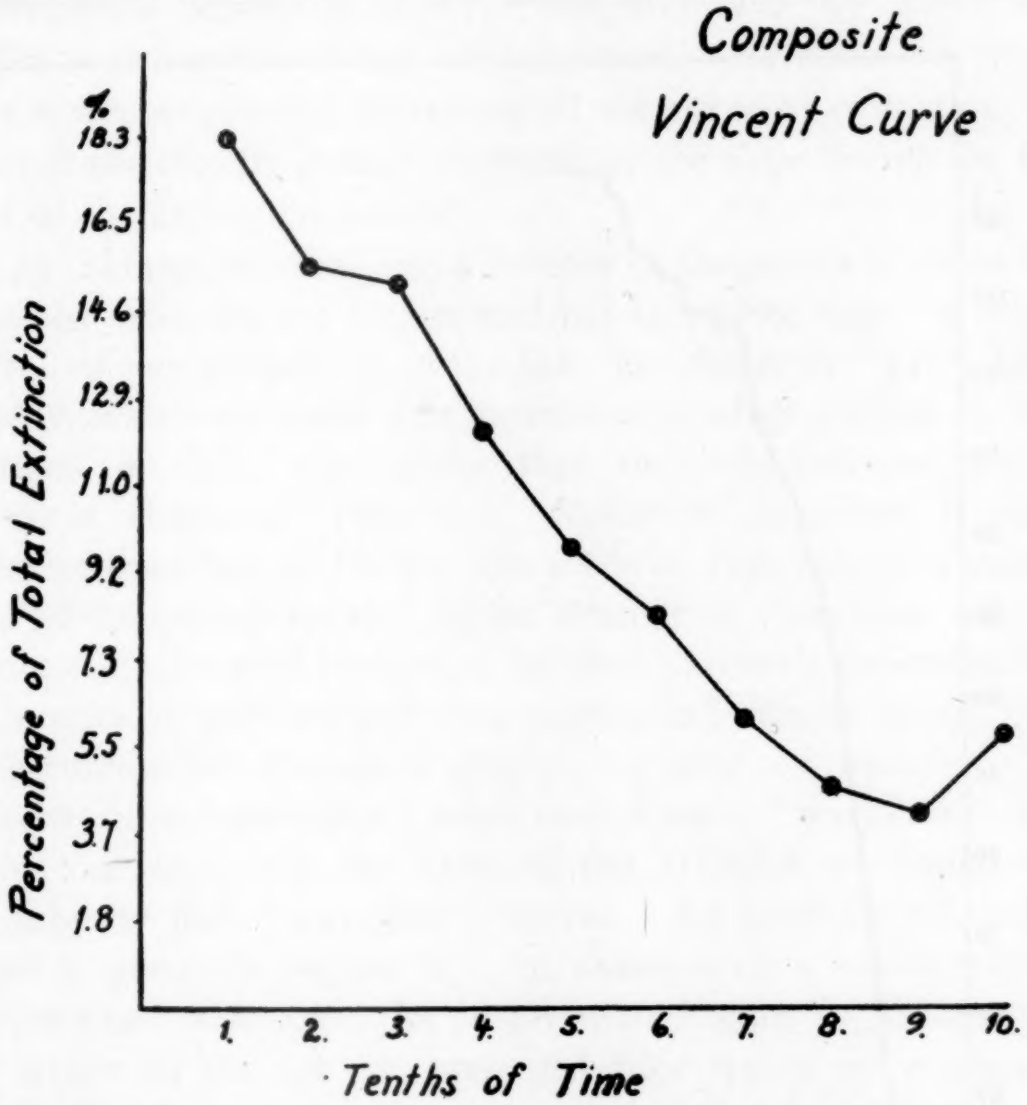

FIGURE 7. Composite Vincent curve of experimental extinction of Projects 1, 2, and 3, but exclusive of subjects 11, 15, and 22 of Project 3 who showed Huge Errors. The time, exclusive of the five-minute criterion, is plotted on the X axis. The values along the Y axis represent the percentages of the total number of responses made during each tenth of the extinction time. The curve is based upon a total of 2533 responses made by 43 subjects.

"usually shows a fairly steep fall at the beginning, which gradually approaches the horizontal as complete extinction is approximated" (43, 438).

Finch and Culler have insisted that there is no typical curve of extinction. They state that ". . . C–R is by no means a

mere stereotype which customarily falls at a certain rate when the primary stimulus is omitted" (20, 659). According to Finch and Culler a curve can be called typical only ". . . save as certain conditions of motivation are typical" (20, 659). If we assume this criticism to be valid, we are compelled to say that

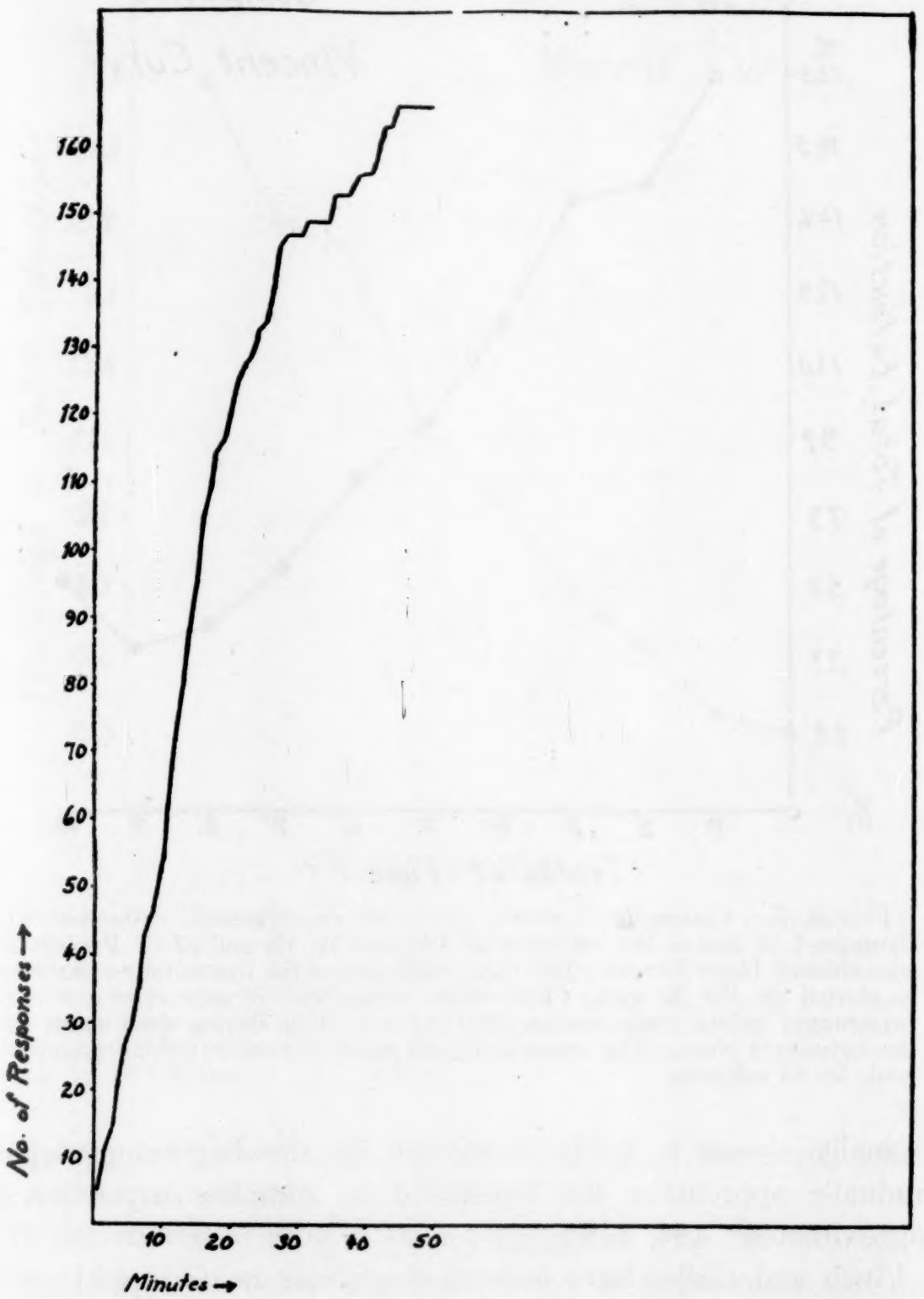

FIGURE 8. An example of a "wave-like" curve (Project 2, subject 3).

our curves of extinction are typical only in our particular situations, which may be true. But we find not only that the Vincent curves of this study are similar to one another but also that they are similar to one of the types outlined by Hull, even though the motivational situations differ. The statement by Finch and Culler is not substantiated. *Two general tendencies are found.* One is the progressive decrement of the curve of extinction; the other is the slightly greater steepness of the slope during the first part of the extinction process.

(2) Skinner has analyzed a number of the curves of extinction obtained from his rat studies and has concluded that "a typical curve of extinction is wave-like in character" (102, 123). Pavlov, who mentioned that extinction is often subject to fluctuations (80, 50), also states that the "fluctuations are of rhythmic character" (80, 51). Skinner's statement is more inclusive than that of Pavlov who made no reference to a general type of extinction curve. In an attempt to determine whether or not our curves of extinction fulfilled Skinner's generalization, the results of each subject were plotted individually in the form of accumulative frequency graphs, as done by Skinner. We called a curve "wave-like" when two or more "wave-like" deviations occurred. On the basis of this criterion we found that 17 subjects had "wave-like" curves. An example of such a curve is given in Figure 8. An example of a curve without "wave-like" characteristics is given in Figure 9. Skinner, in his article on the subject, presented four typical curves having "wave-like" characteristics and stated that other curves in his possession did not differ markedly from the typical one (102, 123). In our analysis we found that only 37 per cent of the subjects showed "wave-like" curves. We cannot, therefore, call such curves typical.[16]

[16] Arakelian has recently performed a series of experiments on "Cyclic Oscillations in the Extinction Behavior of Rats" which is relevant to Pavlov's and Skinner's hypotheses concerning rhythmic alternations during the extinction process. There is evidence, according to Arakelian, that such characteristics exist with rats during the extinction process. Arakelian's studies, which were conducted at the Hull Unit of the Institute of Human Relations at Yale University, are in press in the *Journal of General Psychology.*

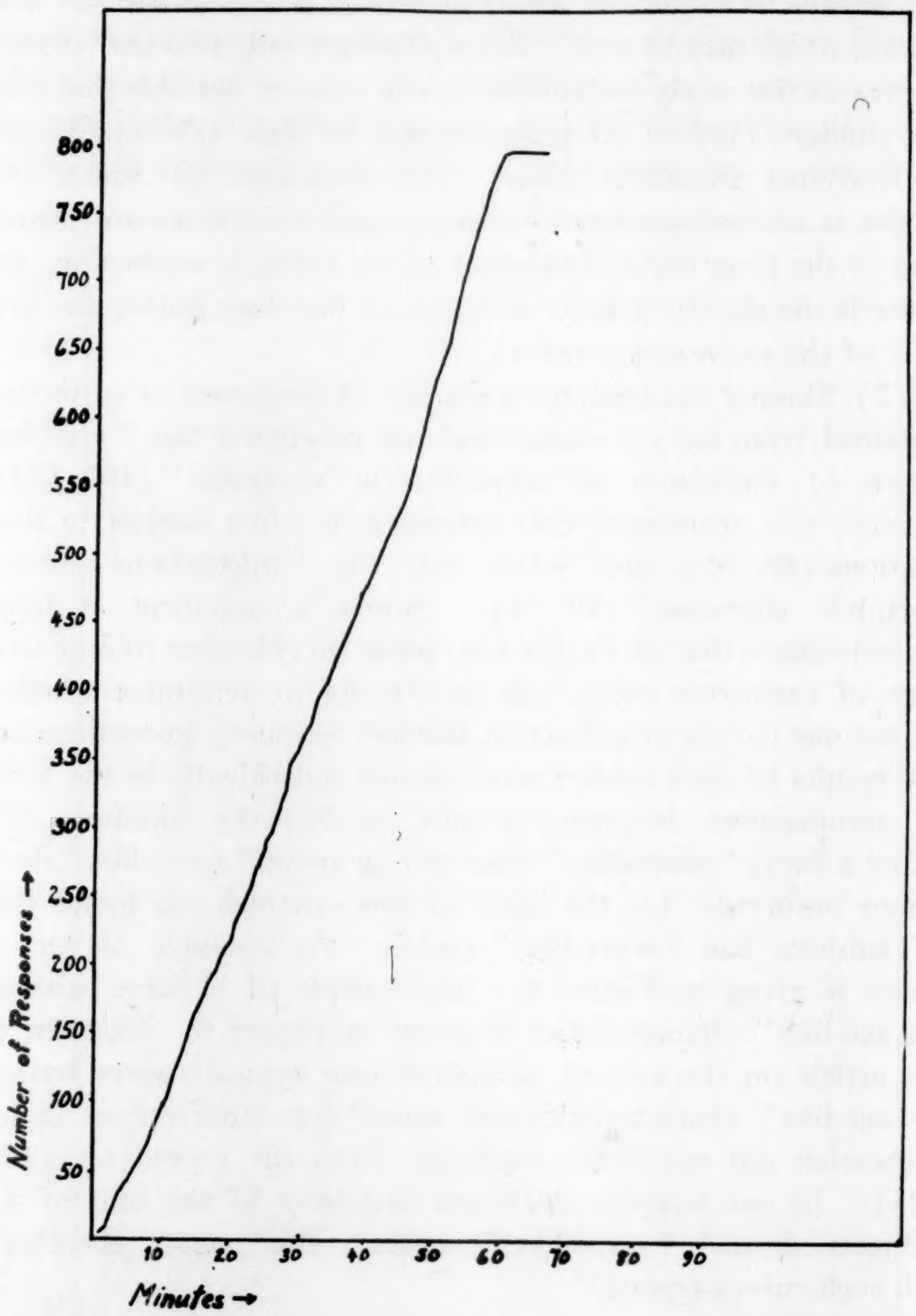

FIGURE 9. An example of a curve without "wave-like" characteristics (Project 3, subject 22).

Skinner attributes the oscillations to an "emotional" change. Miller and Stevenson, in a study of extinction phenomena (76, 225) do not corroborate Skinner. Miller and Stevenson rated

their rats as "agitated" or "non-agitated" and did not find that the "agitated" rats showed more oscillations on the extinction curves than the "non-agitated" rats. We did not rate our subjects on the basis of agitated behavior and thus cannot come to any conclusion in the matter. Nevertheless, we feel that the point raised by Skinner is an intriguing one and merits further study, especially with human beings. The hypothesis might be tested with psychotic patients by comparing manic subjects with schizoid subjects. On the basis of Skinner's hypothesis it would be expected that the schizoid subjects, who are relatively immune to emotional disturbances, would not show the oscillations as frequently as the manic or more active type of subject.

Pavlov's interpretation of the deviations does not differ materially from that of Skinner. Pavlov assumes that extinction is an aspect of inhibiton. He then adds, "The spontaneous rhythmic fluctuations in the reflexes sometimes observed during the process of experimental extinction can now easily be explained as a manifestation of the struggle which is taking place between the nervous processes of excitation and inhibition before one or the other gains mastery" (**80**, 60–61). In our study we find that of the 37 per cent of the subjects who had "wave-like" curves, 86 per cent showed the phenomenon only during the latter part of the extinction process. It might be inferred that the "emotional" aspects (Skinner) or the "excitation-inhibition" struggle (Pavlov) are manifested during the end of the extinction process.

D. *Subjects' behavior during extinction:*

During the extinction period the experimenter recorded the observations of the subject's behavior on the polygraph paper. Unfortunately, the information thus obtained cannot be treated systematically. However, we have analyzed the notes and have arrived at the following results: 57 per cent of the subjects showed obvious symptoms of frustration; 48 per cent displayed "problem-solving" tendencies; with 36 per cent of the subjects the drive to obtain candy persisted after they had ceased inserting the chip into the machine; 20 per cent of the subjects displayed all

three characteristics. It is of special interest to us that 36 per cent of the subjects persisted in attempts to obtain candy after the poker chip had been discarded as the means to the end. Such a finding compels us to question the meaning of the term " extinction ".

If we mean by " extinction " that the subject stopped reacting to a conditioned stimulus, then, the very definition precludes argumentation. If, however, we imply in the use of the term extinction that the drive of the subject to obtain the candy was also diminished, then we must take account of the observations in this study. Many a subject, although he may have stopped reacting to the poker chip as a stimulus, was nevertheless intent on getting the candy. In his attempts, he employed methods which might prove feasible. He blew into the slot machine, tried putting the chip into the chute, kicked the machine, banged on the partition, and wept. Apparently the subject had not become conditioned to the poker chip as the only means of attaining the objective.

To obtain complete " extinction " of the subject's behavior to the persisting drive stimulus, it would probably have been necessary to extinguish each of the many excitatory tendencies conditioned to the persisting drive stimulus. However, only one such excitatory tendency was measured for extinction: that of the " poker-chip—candy ". It sometimes happened that the " poker-chip—candy " tendency was extinguished while other excitatory tendencies aroused by the candy stimulus were in operation. Thus, for example, if the subject busied himself for five minutes with attempts to kick the machine apart in order to get the candy, he was simultaneously being recorded as extinguishing on the " poker-chip—candy " tendency. For this reason, it would be unlikely that the record of the total strength of the subject's reactions with the poker chip would measure precisely the total strength of the subject's excitatory tendencies in the situation. Our criticism does not imply that principles of conditioning cannot be used as satisfactory explanatory concepts of adaptive behavior in human beings but, none the less, we cannot restrict ourselves to the usual C–R paradigm in explaining adaptive

behavior. Additional concepts are necessitated. Hull has used principles of conditioning in conjunction with other principles obtained from animal experimentation to show the manner in which such adaptive behavior may be explained (44, 46).

Summary

This study was made to determine the characteristics of experimental extinction in a human goal situation. The investigation differed from the usual conditioned-response experiment inasmuch as the subject was in an "active" rather than a "passive" situation; *i.e.,* he could control his own movements in reference to the goal, and he himself initiated the next presentation of the stimulus. The following results were obtained:

(1) The mean number of responses during extinction was 94; the range of responses was from 1 to 799. In these respects our study differs from the usual conditioned-reaction study since in such studies extinction takes place quickly and the range of responses is smaller. But our results agree with those of Hunter who experimented with white rats in a similar behavioral situation. It is possible that the greater degree of behavioral freedom permits the operation of disinhibitory factors, thus lengthening the course of extinction. Irrespective of the differences between our results and those of the traditional conditioned-response study, there is a very important point of agreement: *extinction is obtained in both instances.*

(2) There was a high and reliable degree of correlation between number of responses and time for extinction, suggesting, therefore, that either variable may be used to measure the strength of extinction.

(3) Correlations between MA and extinction responses, MA and extinction time, LA and extinction responses, and LA and extinction time were negligible, as would be expected from a conclusion by Hilgard to the effect that, "There is no more a common factor of conditionability than there is of learning."

(4) Pavlov states that the shorter the length of pause between successive repetitions of the non-reinforced stimulus, the more

quickly will extinction occur. There is some indication of such a tendency in this study.

(5) Eighty-three per cent of the subjects made more responses during the first half of extinction time than during the second half, thus substantiating, for large magnitudes, Pavlov's statement that extinction is progressive.

(6) The curve of extinction was similar to one of the types outlined by Hull in his review of the literature of conditioning. Two general characteristics were found: a progressive decrement in response during extinction and a slightly greater steepness of the slope during the first part of the extinction process.

(7) Thirty-seven per cent of the subjects showed "wave-like" curves. Of those who displayed "wave-like" deviations, 86 per cent manifested the phenomenon only during the latter part of the extinction process.

(8) Thirty-six per cent of the subjects persisted in their attempts to secure candy even though they had ceased reacting with the poker chip. Such a finding suggests that extinction may be but one measured aspect of frustration.

IV. SPONTANEOUS RECOVERY

Spontaneous recovery may be defined as the tendency of an extinguished conditioned reaction to recover some or all of its strength after an interval of time (**80**, 58). Pavlov states that "all those conditioned reflexes which have been fully established invariably and spontaneously return sooner or later to their full strength" (**80**, 58). Hull has pointed out that spontaneous recovery marks one of the important differences between curves of extinction and curves of forgetting (**43**, 438).

The work on the nature of spontaneous recovery has been meager. Perhaps the most important research (aside from the work of the Russians) is that of Switzer on the galvanic-skin reaction (**112**). Switzer tested for spontaneous recovery at intervals from 3.5 hours to 16 days after the original extinction. His results do not support Pavlov's conclusion of complete recovery. Switzer comments, however, that "this is not a limitation on the Pavlovian dictum, but is probably the result of a failure in this experiment to meet the definite criterion of 'full establishment' and the decidedly elusive one of 'sooner or later'" (**112**, 95–96). Hovland (**33**), Hull (**45**), Miller and Miles (**74**, **75**), Miller and Stevenson (**76**), and Porter (**83**) have also published data relevant to spontaneous recovery. Finch and Culler (**20**) and Miller and Miles (**75**) have posited theories in reference to the nature of spontaneous recovery.

In the traditional conditioned-response experiment the subject is essentially passive; that is, he is not permitted behavioral freedom. Moreover, in such studies the subject does not control the presentation of the stimulus. In our studies the subject is not only permitted behavioral freedom, but is also in control of the presentation of the stimulus. In view of these differences we may raise the question:

If the mechanisms underlying the stimulus-response sequence of this study are the same as those underlying the usual conditioning experiment, spontaneous recovery should occur. Moreover, the degree of spontaneous recovery should increase with

interval of time following the previous extinction. Our problem consisted, therefore, in testing for spontaneous recovery (a) five minutes following the first extinction and (b) four months following the first extinction. It it can be assumed that the greater the interval of time between successive extinctions, the greater the degree of spontaneous recovery,. then we should expect a greater degree of recovery after an interval of four months than after an interval of five minutes. If a lapse of four months fulfills the indefinite criterion of "sooner or later" we should expect recovery to be complete after that interval.[17]

Since our subjects were also available on the day after the extinction at the four-month interval, they were subjected to extinction on that day also. Concerning the effects of this day's extinction, no deductions can be made. Because of the effects of non-reinforcement on the previous day, it might be predicted that this day's extinction should occur more rapidly. However, a greater degree of recovery is to be expected between the third and fourth extinctions (24-hour interval) than between the first and second extinctions (5-minute interval).

Procedure

Eight subjects were employed in this study. They ranged in Binet mental ages from 2.0 to 2.8 years and in life ages from 7.0 to 12.7 years. The mean mental age was 2.3 years and the mean life age was 9.7 years. The conditions of experimentation were as follows:

(1) The subject was taught to perform the behavior sequence Ru—Rv—Rw—Rx and allowed ten reinforcements.

(2) Following the ten reinforcements, he was taken from the

[17] These assumptions are subject to the qualification that the rate of extinction is affected by the number of times the organism has previously undergone extinction. Pavlov considers this variable in a discussion of the factors influencing rate of extinction. He states: "The final condition which influences the rate of experimental extinction is the number of times the given reflex has been subjected to extinction in the same animal. After each fresh extinction of a conditioned reflex the number of unreinforced conditioned stimuli required to produce the next experimental extinction is less, until in the end a zero reaction results in some dogs from only a single application of the unreinforced conditioned stimulus" (**80**, 54). Porter arrived at essentially the same conclusion in a recent study (**83**, i).

room for an interval of five minutes. He was then returned and was subjected to extinction on the chip-candy machine.[18]

(3) After the completion of the first extinction he was removed from the room for a period of five minutes, and then returned for the second extinction on the chip-candy machine.[19]

(4) After completing the second extinction the subject was removed from the room for five minutes and then subjected to satiation on the marble-chip machine.[20]

(5) The subjects were subjected to extinction on the chip-candy machine four months later.

(6) A day after the last extinction, the subjects were again subjected to extinction.

Results

The results are summarized in terms of the following questions:

(A) How does the mean number of responses vary in the successive extinctions?

(B) How does the mean extinction time vary in successive extinctions?

(C) What is the degree of spontaneous recovery for each extinction?

(D) How many subjects show complete spontaneous recovery?

(A) *How does the mean number of responses vary in the successive extinctions?*

The results are presented in Table 14. It will be seen that the mean number of responses for the second, third, or fourth extinction was never greater than the mean number of responses for the first extinction. The greater the time interval between the first extinction and the successive extinction, the larger is the mean number of responses for extinction. The $D/\sigma D$ of each mean from the mean of the first extinction period shows that the results belong to different statistical universes. The reliability

[18] Both the marble-chip and the chip-candy machines were present during extinction.

[19] The disinhibiting stimulus, noise from buzzers, was given during the first and second extinctions. The results of disinhibition are to be found in the thesis filed in the Yale Library.

[20] The results of chip satiation are to be found in the thesis filed in the Yale Library.

TABLE 14

MEAN NUMBER OF RESPONSES FOR THE SUCCESSIVE EXTINCTIONS

Extinction Period	Mean Number of Responses	σM	$\frac{D}{\sigma D}$ of Each Mean from Mean of 1st Extinction Period
1st	71.1	19.6	
2nd (five minutes after the 1st extinction)	9.1	7.7	4.31
3rd (four months after the 1st extinction)	29.6	9.4	3.05
4th (24 hours after the 3rd extinction)	42.1	13.0	1.79

of the difference decreased as the time interval between the first extinction and successive extinction periods increased, as would be expected. The means of Table 14 are illustrated graphically in Figure 10.

(B) *How does the mean extinction time vary in successive extinctions?*

The results are presented in Table 15. This table shows the same relationships as found in Table 14. The mean time for the

TABLE 15

MEAN TIME TAKEN FOR EXTINCTION, IN SECONDS, DURING EACH EXTINCTION PERIOD

Extinction Period	Mean Time Taken for Extinction [21]	σM	$\frac{D}{\sigma D}$ of Each Mean from Mean of 1st Extinction Period
1st	941″	247″	
2nd (five minutes after the 1st extinction)	110″	106″	3.98
3rd (four months after the 1st extinction)	343″	108″	3.32
4th (24 hours after the 3rd extinction)	724″	193″	.91

[21] The five-minute period terminating an extinction trial is not included.

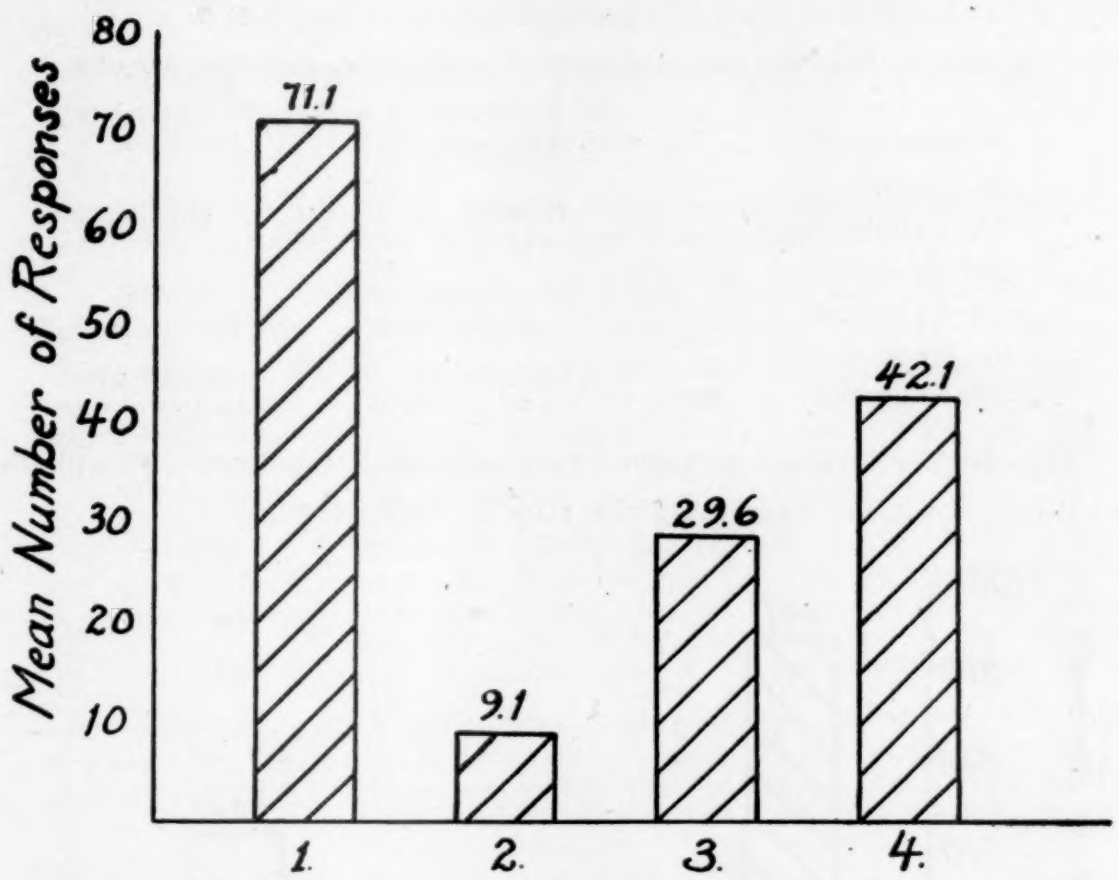

FIGURE 10. Column diagram showing mean number of responses during extinction at various stages of experimental procedure.

1. Mean number of responses of 1st extinction.
2. Mean number of responses of 2nd extinction. The 2nd extinction followed five minutes after the 1st extinction.
3. Mean number of responses of 3rd extinction. The 3rd extinction followed four months after the 1st extinction.
4. Mean number of responses of 4th extinction. The 4th extinction followed four months and a day after the 1st extinction.

second, third, or fourth extinction period was never greater than the mean time for the first extinction period. The greater the time interval between the first extinction and the successive extinction, the larger is the mean time for extinction. The $D/\sigma D$ of each mean from the mean of the first extinction shows the same statistical tendency as in Table 14. The means of Table 15 are illustrated graphically in Figure 11.

(C) *What is the degree of spontaneous recovery for each extinction?*

If the mean of the first extinction period is divided into the means of the second, third, and fourth extinction periods, the following percentages of spontaneous recovery are obtained:

TABLE 16

DEGREE OF SPONTANEOUS RECOVERY CALCULATED FROM THE MEANS

Comparisons	In Reference to Responses	In Reference to Time
2nd extinction / 1st extinction	12.80%	11.69%
3rd extinction / 1st extinction	41.63%	36.45%
4th extinction / 1st extinction	59.21%	76.94%

The degrees of spontaneous recovery for responses are similar to those for time except in the fourth extinction.

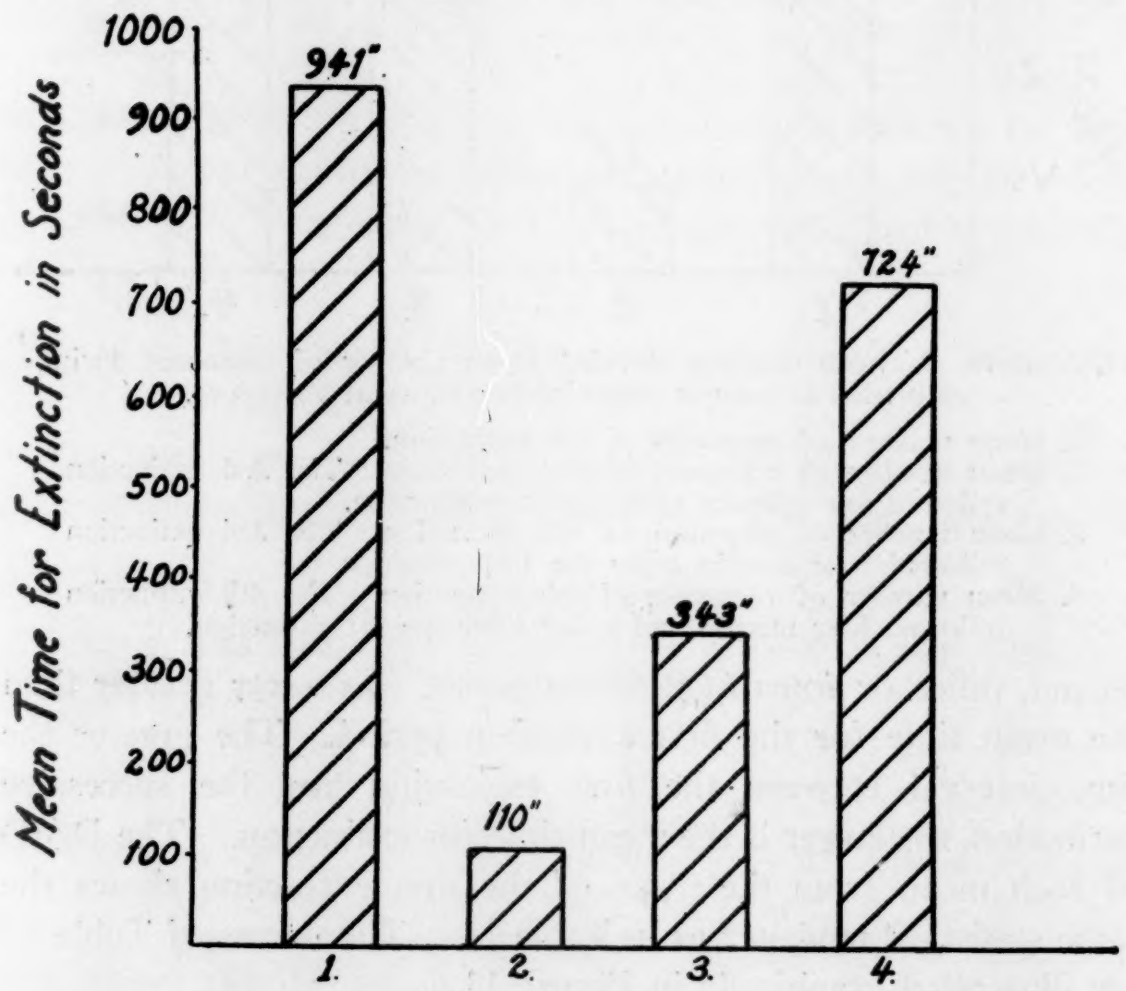

FIGURE 11. Column diagram showing mean time for extinction in seconds at various stages of experimental procedure.

1. Mean time for 1st extinction.
2. Mean time for 2nd extinction. The 2nd extinction followed five minutes after the 1st extinction.
3. Mean time for 3rd extinction. The 3rd extinction followed four months after the 1st extinction.
4. Mean time for 4th extinction. The 4th extinction followed four months and a day after the 1st extinction.

(D) *How many subjects showed complete spontaneous recovery?*

The results are presented in Table 17.

TABLE 17

NUMBER OF SUBJECTS WHO SHOWED COMPLETE SPONTANEOUS RECOVERY DURING THE 2ND, 3RD, AND 4TH EXTINCTIONS

Extinction Period	In Terms of Number of Responses for Extinction	In Terms of Time Taken for Extinction
2nd extinction (five minutes after the 1st extinction)	*0 out of the 8 subjects* made as many or more responses during the 2nd extinction as during the 1st extinction	*0 out of the 8 subjects* took as much time or more for the 2nd extinction as during the 1st extinction
3rd extinction (four months after the 1st extinction)	*2 out of the 8 subjects* made as many or more responses during the 3rd extinction as during the 1st extinction	*2 out of the 8 subjects* took as much time or more for the 3rd extinction as during the 1st extinction
4th extinction (24 hours after the 3rd extinction)	*2 out of the 8 subjects* made as many or more responses during the 4th extinction as during the 1st extinction	*4 out of the 8 subjects* took as much time or more for the 4th extinction as during the 1st extinction

The results of this table indicate that the greater the lapse of time between the first extinction and subsequent extinctions, the greater the number of subjects who showed complete spontaneous recovery. Fifty per cent of the subjects showed complete recovery during the fourth extinction, in terms of time for extinction. In terms of response, only 25 per cent of the subjects showed complete recovery during the fourth extinction. This latter percentage is the same as that obtained during the third extinction in terms of either response or time. None of the eight subjects showed complete recovery during the second extinction.

DISCUSSION

Although the subjects were permitted behavioral freedom and controlled the presentation of the stimulus, spontaneous recovery was found in accordance with expectations from conditioned-reaction experiments. The greater the lapse of time between the first extinction and the successive extinction, the greater the degree of spontaneous recovery. If the means are used as the

bases of calculation, there is about 12 per cent recovery after five minutes, 39 per cent recovery after four months, and 68 per cent recovery after four months and a day.[22] But spontaneous recovery was not complete in all cases after an interval of four months. This finding agrees with the results of Switzer, but is not in agreement with Pavlov's expectations. It is necessary to consider the factors which might account for the discrepancy. Pavlov postulates two conditions for complete spontaneous recovery, namely: the conditioned reflex must at one time have been fully established, and a period of time of "sooner or later" must elapse between the first and second extinctions. That the first condition was met in this experiment is demonstrated, since all the subjects reacted when brought into the experimental room for the first extinction. The second condition of "sooner or later" is a decidedly indefinite one, as Switzer has stated, and, therefore, is difficult to meet. Nevertheless, four months seems to be an adequate period of time.

There is yet another factor: the restoration of a conditioned reflex is also dependent upon the number of times it has been subjected to previous extinction (**80**, 59). In our study, the extinction at the four-month interval had been preceded by two previous extinctions.[23] These two previous extinctions may explain why only 25 per cent of the subjects showed complete recovery after four months. It would be interesting to run a control experiment in which the subjects would be tested for extinction after the habit was set up and then again four months later. If our inference is correct, such an experiment would show that more than 25 per cent of the subjects would obtain complete recovery. The difference between the results of such an experiment and this study would be attributed presumably to the fact that in this study an extinction period was introduced five minutes after the first extinction.

There is one aspect of our investigation which merits more

[22] These means are averages, in each case, of the mean for responses and the mean for time.

[23] It will be recalled that chip-satiation was also carried out. This followed five minutes after the second extinction.

consideration than we have thus far given it. It concerns the results of the fourth extinction. It is found that the mean number of responses and the mean time for extinction of the fourth extinction period are greater than the respective means of the third extinction period. It is found that the critical ratio for responses between these two periods is 1.3 and the critical ratio for time is 2.1. The chances are 90 out of 100 in the first instance and 96 out of 100 in the second instance that the results belong to different statistical universes. Four of the eight subjects gave more responses for the fourth extinction than for the third extinction; six of the eight subjects took more time for the fourth extinction than for the third extinction. There is some suggestion of a true difference, although the evidence is questionable. Because of such results we interpret the spontaneous recovery of the fourth extinction as recovery after 24 hours (following the third extinction) rather than recovery after four months and a day.

Conclusions

In the traditional conditioned-response experiment the subject is essentially passive and does not control the presentation of the stimulus. In this study the subject had relative behavioral freedom and controlled the presentation of the stimulus. In spite of these differences, it was found that (1) spontaneous recovery was present; (2) there was more spontaneous recovery after a four-month interval than after a five-minute interval; (3) complete spontaneous recovery occurred with 25 per cent of the subjects in terms of responses or time after an interval of four months. These results are in agreement with those found in conditioning experiments, except that after an interval of four months more spontaneous recovery would be expected to take place than was found in this study. However, in this experiment, conditions were introduced which probably account for the difference between our results and those of Pavlov. A control experiment is suggested.

V. CURVES OF SATIATION IN HUMAN SUBJECTS

Introduction

In a recent study of satiation, using white rats, Skinner has demonstrated that "The rate at which a white rat eats a daily ration of a standard food varies in a uniform way. The amount of food (N) eaten at any time (t) during an eating period is given by the equation $N=Kt^n$ where K and n are constants" (**99**, 35). Skinner also shows that the value of n, in his experimental situation, varies between 0.68 and 0.70 (**99**, 38).

Our apparatus permitted the study of the phenomena of satiation in human beings under conditions analogous to those operative in Skinner's experiments with rats. We were interested in determining to what extent our data with human beings agreed with Skinner's results with white rats.

Apparatus and Procedure

Since there were three groups of subjects and since there were variations with each group, the descriptions of apparatus and procedure will be divided into three sections.

Group A. The apparatus employed with Group A consisted of two mechanisms. One machine, upon the insertion of marbles, yielded poker chips; the other machine, upon the insertion of poker chips, yielded chocolate candy of a uniform size. The machines were placed side by side, one foot apart, and three and one-half feet from the floor. For further details of apparatus, see the General Introduction.

Each subject in this group was taught to obtain a marble from the near-by chair, put the marble into the marble-chip machine, secure a chip, put the chip into the chip-candy machine, and get a piece of candy and eat it. The subject was permitted to run through this behavior sequence ten times.

After the subject received the training described above he was

taken out of the research room for a period of five minutes. When returned to the room he was permitted to eat candy until satiated. To bring about satiation the procedure was as follows: 500 chips were placed on the chair in the experimental room. From this pile the subject could obtain chips to put into the chip-candy machine in exchange for candy. The subject was permitted to have only one piece of candy at a time. If a second chip were inserted before the candy obtained from the previous chip had been eaten, the circuit of the chip-candy machine was interrupted by the experimenter, thus preventing the ejection of the candy. The subject was regarded as satiated if he did not put a chip into the chip-candy machine for a period of five minutes. After the criterion of satiation had been met, the subject was taken from the room.

Group B. The apparatus employed with the subjects of Group B consisted also of two mechanisms. One machine, upon the pulling out of a knob, yielded poker chips; the other machine (the same one as that employed with Group A) upon the insertion of poker chips, yielded chocolate candy. The machines were placed side by side, one foot apart, and three and one-half feet from the floor.

Each subject in this group was taught to pull the knob of the knob-chip machine, obtain a chip, put the chip into the chip-candy machine, and get a piece of candy and eat it. The subject was permitted to run through this behavior sequence ten times.

After the subject received the training described above, he was taken out of the room for a period of five minutes. He was then brought back into the room and permitted to eat candy until satiated. The procedure in satiation was the same as during the preliminary training. The subject could obtain a chip by pulling out the knob of the knob-chip machine; this chip could then be inserted into the chip-candy machine and the candy obtained and eaten. The behavior sequence never varied. The subject had to pull the knob of the knob-chip machine, get a chip, put the chip into the chip-candy machine, get a piece of candy and eat it. He could not pull the knob of the knob-chip machine and obtain another chip before the previous piece of candy obtained had been

eaten. Neither could he pull the knob more than once. He could not, therefore, hoard chips.[24] The subject was regarded as satiated when he did not put a chip into the chip-candy machine for a period of five minutes. After the criterion of satiation had been met, the subject was taken from the room.

Group C. No preliminary training of any kind was given to the subjects of Group C and only the chip-candy machine was used. The subject was brought into the experimental room in which 500 chips had been placed on a chair. He was shown how to obtain candy by putting a chip into the chip-candy machine. Only one piece of candy could be obtained at a time and this piece of candy had to be eaten before the next piece of candy was obtainable. When the usual criterion of satiation was met, the trial for the day was terminated and the subject was returned to his cottage.

Subjects. There were 11 subjects in Group A, 13 in Group B, and 5 in Group C. The subject characteristics in terms of Binet mental age and life age are given in Table 18.

TABLE 18

CHARACTERISTICS OF THE EXPERIMENTAL GROUPS WITH RESPECT TO BINET MENTAL AGE (MA) AND LIFE AGE (LA)

	Group A			Group B			Group C	
Subject	MA	LA	Subject	MA	LA	Subject	MA	LA
1	2.4	6.2	1′	4.7	17.5	1″	3.0	29.3
2	2.8	7.4	2′	4.7	13.3	2″	4.8	14.7
3	2.5	9.6	3′	5.9	18.1	3″	3.9	10.2
4	2.0	10.2	4′	4.3	40.6	4″	3.8	24.4
5	2.0	11.2	5′	4.4	16.3	5″	3.5	8.5
6	2.4	11.2	6′	5.2	27.1			
7	2.0	11.4	7′	4.3	15.3			
8	2.9	11.9	8′	5.3	11.0			
9	2.4	12.0	9′	4.7	20.9			
10	2.9	12.4	10′	5.5	36.8			
11	3.0	12.7	11′	4.7	26.4			
			12′	4.2	11.5			
			13′	2.5	35.2			
M	2.5	10.6		4.6	22.3		3.8	17.4
σ	.8	3.8		1.1	10.0		.4	5.4
$\sigma_{av.}$	.2	1.1		.3	2.8		.1	1.5

[24] The experimenter locked the release mechanism of the knob so that the knob could not be pulled out.

Results and Discussion

Preliminary to the treatment of the general problem we shall consider the curves of satiation of Groups A, B, and C. It will be recalled that Groups A and B had been given preliminary training; Group A had received ten trials on the marble-chip and chip-candy mechanisms; Group B had received ten trials on the knob-chip and chip-candy mechanisms. Groups A and B followed similar procedures in that the members of each group obtained ten pieces of candy from the chip-candy machine. But the groups differed in that with Group A the marble-chip machine was used in conjunction with the chip-candy machine, whereas

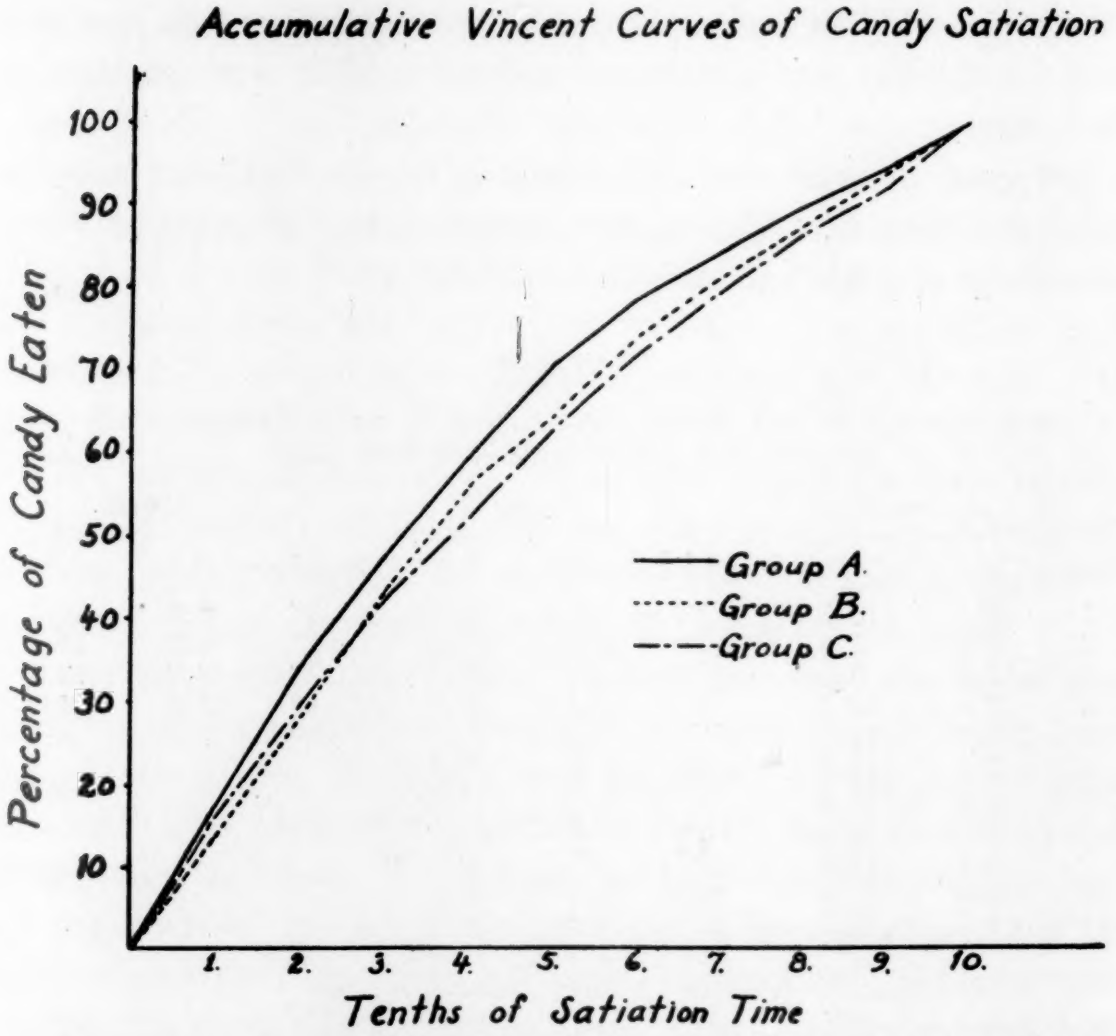

Figure 12. Accumulative Vincent curves of candy satiation. The X axis represents the time taken for satiation exclusive of the five-minute criterion of satiation. The Y axis represents the percentage of the total candy eaten at any period of time. The curve for Group A (11 subjects) is based upon a total of 985 pieces of candy; the curve for Group B (13 subjects) is based upon a total of 1195 pieces of candy; the curve for Group C (5 subjects) is based upon a total of 472 pieces of candy.

with Group B the knob-chip machine was used in conjunction with the chip-candy machine. Group C, on the other hand, received no preliminary training or feeding whatsoever. With Groups A and C satiation was carried out by providing 500 chips on a chair to be used to secure candy from the chip-candy machine. The members of Group B, however, had to obtain their chips by pulling on the knob of the knob-chip machine and then putting the chip into the chip-candy machine to get candy. In summary, Groups A and B differed from C in that Group B received training and feeding prior to satiation; also, Groups A and C differed from Group B in that Groups A and C did not

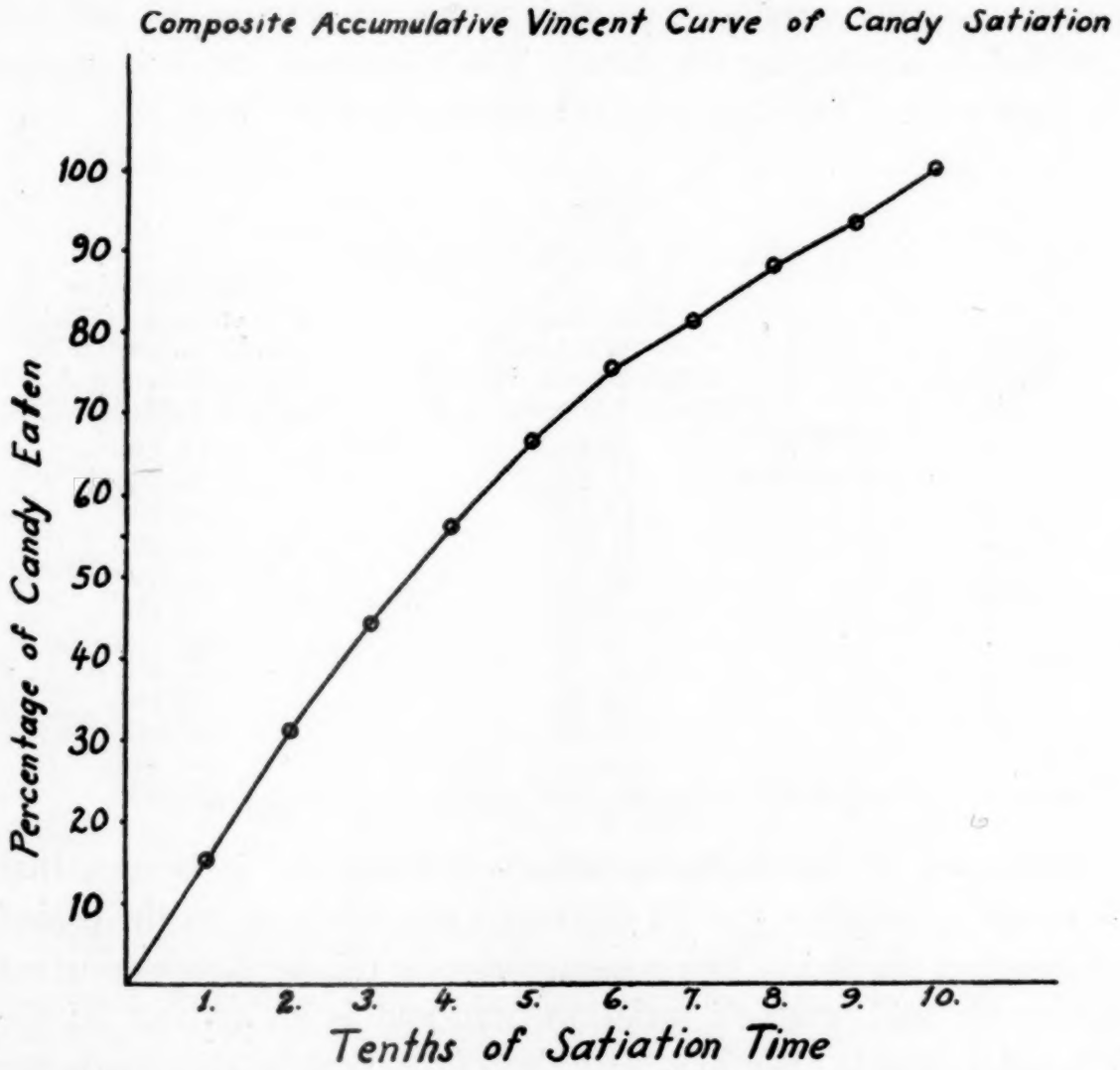

FIGURE 13. Accumulative Vincent curve of satiation plotted from the composite data of Groups A, B, and C. The X axis represents the time taken for satiation exclusive of the five-minute criterion of satiation. The Y axis represents the percentage of the total candy eaten at any period of time. The curve is based upon a total of 2652 pieces of candy.

work for their chips during the period of satiation whereas Group C did so.

The results obtained with these three groups are expressed by means of accumulative Vincent curves in Figure 12. The X axis, divided into 10 equal units, represents the percentage of the total candy eaten at any period of time. Thus we find that the subjects of Group A had consumed 17.5 per cent of their candy at the end of the first tenth of time and 34.6 per cent of their candy at the end of the second tenth of time, and so on.

An inspection of the curves in Figure 12 indicates that they do not differ significantly from one another in spite of the fact that different procedures of training and satiation were employed. Because of the similarity in the curves of Figure 12 we felt justified in combining the data. The composite curve is shown in Figure 13. The data are also summarized in Table 19.

TABLE 19

RATE OF SATIATION TO CANDY

Tenth of Satiation Time	Percentages of Total Candy Eaten During Each Tenth of Satiation Time	Accumulative Percentages of Total Candy Eaten Up To and Inclusive of Any Tenth of Satiation Time
1	15.5%	15.5%
2	15.4%	30.9%
3	13.6%	44.5%
4	11.8%	56.3%
5	10.3%	66.6%
6	8.8%	75.4%
7	6.3%	81.7%
8	6.1%	87.8%
9	5.3%	93.1%
10	6.9%	100.0%
Total	100.0%	100.0%

Referring to the middle column of Table 19, it is seen that there was a tendency toward decreased rate of eating as the period of satiation elapsed. The one exception to this tendency occurred during the last tenth of satiation time and is an artifact of the Vincent method. We may say, therefore, that in this particular experimental situation the rate of eating progressively decreased during the course of satiation.

We now consider the specific question with which we were concerned in the present investigation: Is the curve of satiation found by us similar to that reported by Skinner in his rat studies? According to Skinner, " The amount of food (N) eaten at any time during an eating period is given by the equation $N=Kt^n$ where K and n are constants " (**99**, 35). This equation is represented by the broken-line curve of Figure 14. The value of K, an arbitrary unit, was taken as equal to 20; the constant n was

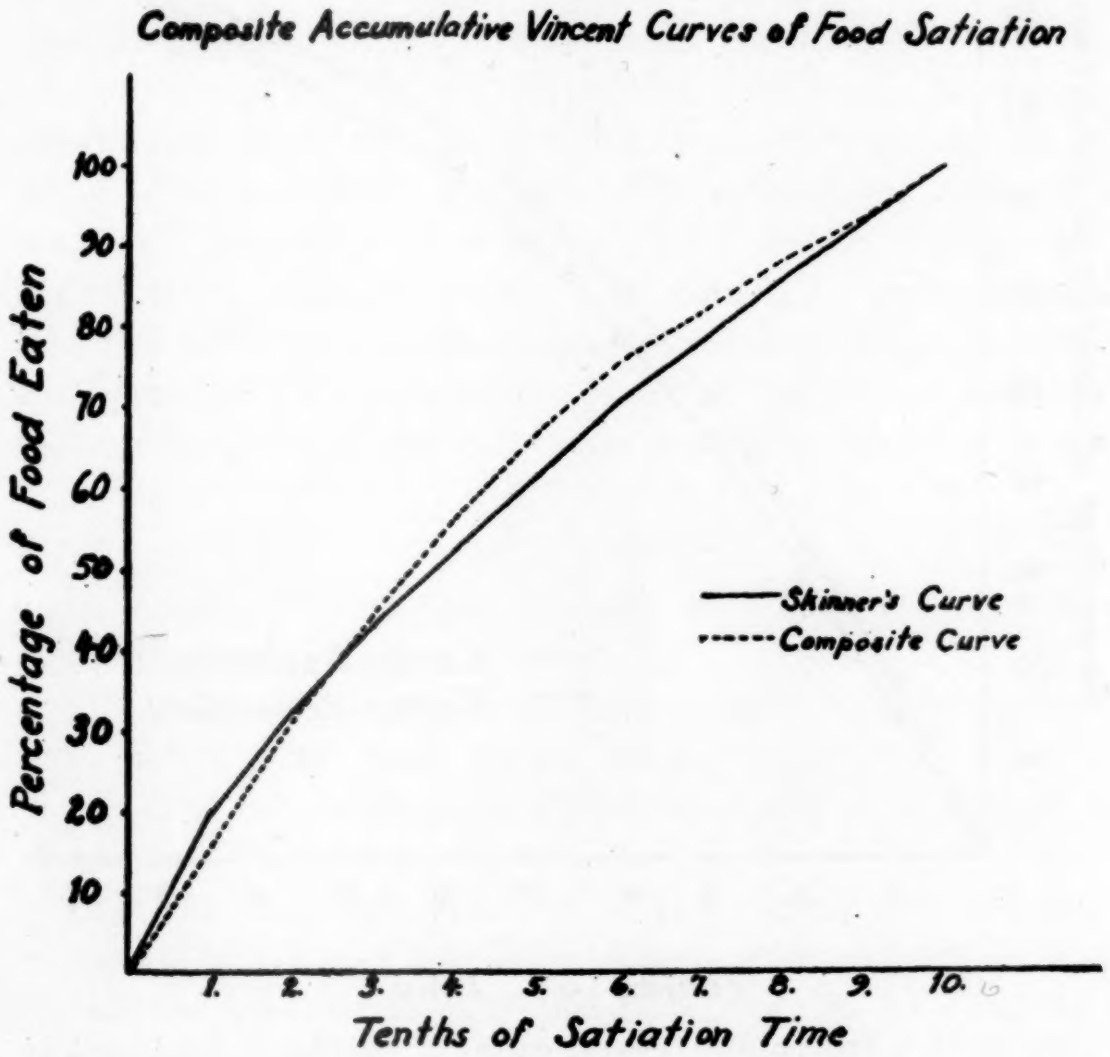

FIGURE 14. Accumulative Vincent curves of satiation to food. The X axis represents the time taken for satiation exclusive of the five-minute criterion of satiation. The Y axis represents the percentage of the total food eaten at any period of time. The unbroken line represents the curve of satiation as plotted from Skinner's equation, $N=K\,t^n$, where K and n are constants. K was arbitrarily given a value of 20; n was given a value of 0.70 in accordance with Skinner. The broken line represents the curve of satiation as plotted from our composite data on satiation. It is the same curve as shown in Figure 13.

given a value of 0.70.[25] The unbroken line represents the course of satiation as plotted from our composite data. It is the same curve as that shown in Figure 13. A comparison of Skinner's theoretical curve and our curve representing the results of the

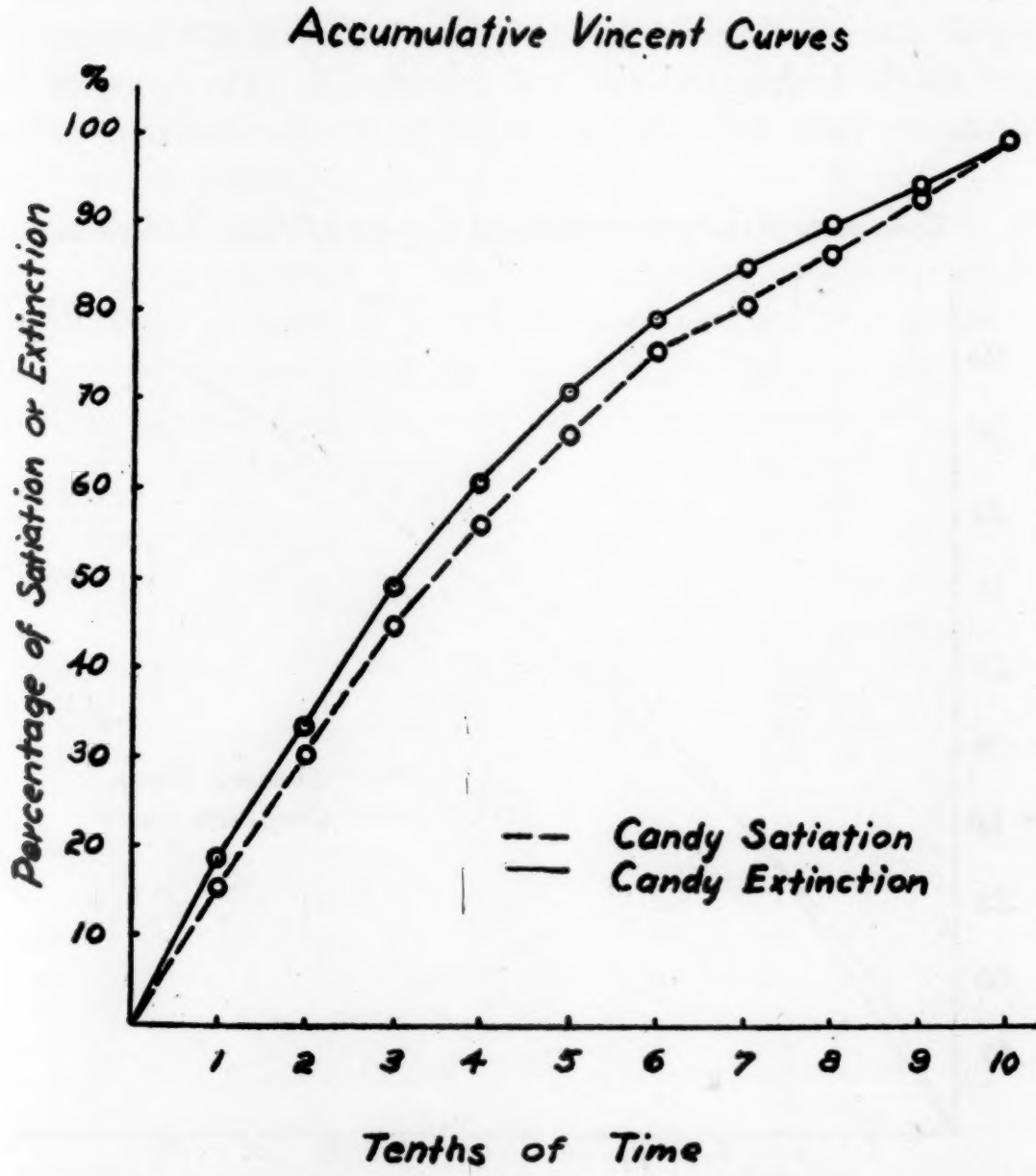

FIGURE 15. Accumulative Vincent curves of satiation to candy and of extinction to chips. The X axis represents the time taken for extinction or satiation exclusive of the five-minute criterion. The Y axis represents the percentage of total satiation or extinction at any period of time. The broken line curve is the same as that shown in Figure 13. It is based upon a total of 2652 pieces of candy, procured and eaten by 29 subjects. The solid line curve was plotted from the curve shown in Figure 7. It is based upon a total of 2533 responses made by 43 subjects.

[25] Skinner found that n varied from 0.68 to 0.70. The use of a value n=0.70 led to a curve which fitted our data more closely than did the curves corresponding to other values of n. This value of n was therefore selected.

present study indicates that they agree quite closely and suggests that our data may be represented approximately by an exponential relation such as given by Skinner's equation. It is to be noted, however, that Skinner's curve starts out with a steeper slope.

In spite of this minor difference, the degree of similarity is striking, and suggests that the same general equation should be capable of describing the process of satiation in mammals, whether it be with white rats or human beings. Both Skinner's curve and the curve of the present experiment would probably constitute special cases of this general equation.

Satiation to Candy vs. Extinction to Chips. Is there any relationship between the curve of extinction to chips and the curve of satiation to candy? To make this comparison, the composite curve of extinction shown in Figure 7 was plotted as an accumulative Vincent curve. This composite curve of extinction is contrasted with the composite curve of satiation to candy in Figure 15. Except for the fact that the curve of extinction is more accelerated, the curves are practically identical in shape.

Conclusions

In a study of satiation to candy with human beings it was found that:

(1) Different procedures of candy satiation with human beings gave curves of the same general form.

(2) The composite curve of satiation was characterized by a progressive decrement.

(3) The composite curve of satiation could not be precisely expressed by Skinner's equation for satiation with rats. Nevertheless, the high degree of similarity between Skinner's curve and our curve suggests that mammalian satiation to food may be expressed by the same general formula. Such a formula would probably permit both Skinner's curve and our curve to be represented as special cases.

(4) The composite curve of satiation to candy was almost identical in shape to the composite curve of extinction to chips.

VI. SUMMARY

Since the publication of Pavlov's work on conditioning some psychologists have inferred that the Pavlovian principles of conditioning were operative with human beings. On the other hand, a considerable number of psychologists have repeatedly asked, "But are the Pavlovian conditioning principles really operative with human beings?" These psychologists have consistently maintained that in the absence of experimental evidence with human beings, no conclusions concerning the applicability of conditioning principles to human beings had been demonstrated.

During the past few years various investigators have supplied evidence to show that conditioning principles, displaying essentially the same characteristics as found by Pavlov, were operative with human beings in such reflex mechanisms as tactile sensitivity, lid reaction, and galvanic response. But in spite of their researches with human beings, their experimental situations remained analogous to those of Pavlov in that the subject played a "passive" rather than an "active" rôle. That is, the human subject, quite like Pavlov's dogs, was strapped or otherwise maintained in such a way that his movements and his behavior did not influence the presentation of the conditioned stimulus. The subjects were in a highly artificial situation. It was our desire to arrange a situation which was "active" or "dynamic" rather than "passive"—a situation wherein the subject would have relatively few behavioral restrictions and could control his own movements in reference to the goal. There is in psychology no term which fits this type of behavior and we have, therefore, called it *goal behavior*. The purpose of this investigation was to determine if conditioning principles were operative in human goal behavior.

The subjects were low-grade, feeble-minded children. The motivation selected was the food urge, as manifested by the striving of the subject to secure small pieces of candy. The apparatus consisted of two mechanisms. One machine yielded poker chips upon the insertion of marbles; the other machine

yielded chocolate candy upon the insertion of poker chips. The behavior sequence generally consisted of inserting a marble into the marble-chip machine, receiving a chip, dropping the chip into the chip-candy machine, and getting and eating a piece of candy. After a series of reinforcements of this sequence, the experimental conditions were varied to satisfy the needs of the investigation.

The findings in this investigation support the thesis that Pavlovian conditioning principles are operative in human goal behavior. Generalization of inhibition, experimental extinction, and spontaneous recovery were found to occur and to display essentially the same characteristics as found by Pavlov. (The reader interested in detailed summaries is referred to the section at the end of each of the studies.) But differences as well as similarities were uncovered. For example, why is extinction longer in these studies, in respect to either responses or time, than in the traditional conditioned-reaction study? Our investigation also leads us to question the interpretation that extinction is the index of frustration. We have evidence to indicate that extinction is only one measured aspect of frustration. A point of real interest to us has been the very high degree of similarity between the curve of extinction to chips and the curve of satiation to candy. Is it possible that identical factors underlie these processes? The determination of the relationships between satiation and extinction may prove a fruitful way of attacking the problems of psychological "refractory phase" proposed by Professor Raymond Dodge.

The essential similarity between our phenomena and those of Pavlov could lead to the conclusion that complex human behavior is reducible to principles of conditioning. It is the author's opinion that although some conditioning principles may be used as explanatory concepts, additional concepts are necessary. The reader, nevertheless, is left to his own devices in interpreting the data. We should merely like to point out that this investigation has clearly demonstrated that conditioning principles can be used as experimental dimensions in attacking psychological problems of human adaptive behavior.

VII. BIBLIOGRAPHY

1. Aldrich, C. G. Experimental studies of idiot behavior. *Proc. Amer. Ass. Stud. Feeble-Minded,* 1931, 36, 282–291.
2. Aldrich, C. G., & Doll, E. A. Problem solving among idiots. *J. comp. Psychol.,* 1931, 12, 137–170.
3. ——— ——— Problem solving among idiots: the use of implements. *J. soc. Psychol.,* 1931, 2, 306–336.
4. Allport, F. H. Motive as a concept in natural science. *Psychol. Rev.,* 1930, 37, 169–173.
5. Anrep, G. V. Irradiation of conditioned reflexes. *Proc. roy. Soc.,* 1923, 94B, 404–426.
6. Bass, M. J., & Hull, C. L. The irradiation of a tactile conditioned reflex in man. *J. comp. Psychol.,* 1934, 17, 47–66.
7. Bayer, E. Beiträge zur zweikomponenten theorie des hungers. *Z. Psychol.,* 1929, 112, 1–54.
8. Brogden, W. J., & Culler, E. Experimental extinction of higher order responses. *Amer. J. Psychol.,* 1935, 47, 663–669.
9. Culler, E., & Finch, G. Higher order conditioning with constant motivation. *Amer. J. Psychol.,* 1934, 46, 596–602.
10. Diserens, C. M., & Vaughn, J. The experimental psychology of motivation. *Psychol. Bull.,* 1931, 28, 15–65.
11. Dodge, R. *Conditions and consequences of human variability.* New Haven: Yale Univ. Press, 1931. Pp. 162.
12. Doll, E. A. Criteria of mental deficiency. *Psychol. Exch.,* 1935, 3, No. 6.
13. Elliott, M. H. The effect of change of reward on the maze performance of rats. *Univ. Calif. Publ. Psychol.,* 1928, 4, 19–30.
14. ——— The effect of appropriateness of reward and of complex incentives on maze performance. *Univ. Calif. Publ. Psychol.,* 1929, 4, 91–98.
15. ——— The effect of change of drive on maze performance. *Univ. Calif. Publ. Psychol.,* 1929, 4, 185–188.
16. ——— The effect of hunger on variability of performance. *Amer. J. Psychol.,* 1934, 46, 107–112.
17. ——— Drive and the characteristics of driven behavior. *Psychol. Rev.,* 1935, 42, 205–213.
18. Elliott, M. H., & Bousfield, W. A. Two basic mechanisms in motivation. *Psychol. Rev.,* 1936, 43, 94–99.
19. Ellson, D. G. Generalization of extinction in a two-segment serial habit. *Psychol. Bull.,* 1937, 34, 513.
20. Finch, G., & Culler, E. Relation of forgetting to experimental extinction. *Amer. J. Psychol.,* 1935, 47, 656–662.
21. Granich, L. An analysis of motivation. *Psychol. Rev.,* 1932, 39, 235–244.
22. Guthrie, E. R. *The psychology of learning.* New York: Harper, 1935.
23. Hilgard, E. R. Conditioned eyelid reactions to a light stimulus based on the reflex wink to sound. *Psychol. Monogr.,* 1931, 41, No. 184.
24. ——— Modification of reflexes and conditioned reactions. *J. gen. Psychol.,* 1933, 9, 210–215.
25. ——— Reinforcement and inhibition of eyelid reflexes. *J. gen. Psychol.,* 1933, 8, 85–113.

26. ——— The nature of the conditioned response: I. The case for and against stimulus-substitution. *Psychol. Rev.*, 1936, 43, 366–385.
27. ——— The nature of the conditioned response: II. Alternatives to stimulus-substitution. *Psychol. Rev.*, 1936, 43, 547–564.
28. ——— The relationship between the conditioned response and conventional learning experiments. *Psychol. Bull.*, 1937, 34, 61–102.
29. HILGARD, E. R., & CAMPBELL, A. A. The course of acquisition and retention of conditioned eyelid responses in man. *J. exp. Psychol.*, 1936, 19, 227–247.
30. HILGARD, E. R., & MARQUIS, D. G. Acquisition, extinction, and retention of conditioned lid responses to light in dogs. *J. comp. Psychol.*, 1935, 19, 29–58.
31. ——— ——— Conditioned eyelid responses in monkeys, with a comparison of dog, monkey, and man. *Psychol. Monogr.*, 1936, 47, No. 212, 186–198.
32. HOLT, E. B. *The animal drive and the learning process, an essay toward radical empiricism.* Vol. I. New York: Holt, 1931. Pp. 264.
33. HOVLAND, C. I. The generalization of conditioned responses. III. Extinction, spontaneous recovery, and disinhibition of conditioned and generalized responses. *J. exp. Psychol.*, 1937, 21, 47–62.
34. ——— The generalization of conditioned responses. I. The sensory generalization of conditioned responses with varying frequencies of tone. *J. gen. Psychol.*, 1937, 17, 125–148.
35. ——— The generalization of conditioned responses. IV. The effects of varying amounts of reinforcement upon the degree of generalization of conditioned responses. *J. exp. Psychol.*, 1937, 21, 261–276.
35a. ——— 'Inhibition of reinforcement' and phenomena of experimental extinction. *Proc. nat. Acad. Sci.*, 1936, 22, 430–433.
36. HUDGINS, C. V. Conditioning and the voluntary control of the pupillary light reflex. *J. gen. Psychol.*, 1933, 8, 3–51.
37. HULL, C. L. A functional interpretation of the conditioned reflex. *Psychol. Rev.*, 1929, 36, 498–511.
38. ——— Knowledge and purpose as habit mechanisms. *Psychol. Rev.*, 1930, 37, 511–525.
39. ——— Simple trial-and-error learning: a study in psychological theory. *Psychol. Rev.*, 1930, 37, 241–256.
40. ——— Goal attraction and directing ideas conceived as habit phenomena. *Psychol. Rev.*, 1931, 38, 487–506.
41. ——— The goal gradient hypothesis and maze learning. *Psychol. Rev.*, 1932, 39, 25–43.
42. ——— Differential habituation to internal stimuli in the albino rat. *J. comp. Psychol.*, 1933, 16, 255–273.
43. ——— Learning: II. The factor of the conditioned reflex. In Murchison, C. (Ed.), *A handbook of general experimental psychology.* Worcester, Mass.: Clark Univ., 1934, 382–455.
44. ——— The concept of the habit-family hierarchy and maze learning: Part I. *Psychol. Rev.*, 1934, 41, 33–52; Part II, 134–152.
45. ——— The rat's speed of locomotion gradient in the approach to food. *J. comp. Psychol.*, 1934, 17, 393–422.
46. ——— The conflicting psychologies of learning—a way out. *Psychol. Rev.*, 1935, 42, 491–516.
47. ——— The mechanism of the assembly of behavior segments in novel

combinations suitable for problem solution. *Psychol. Rev.,* 1935, 42, 219–245.
48. ——— Mind, mechanism, and adaptive behavior. *Psychol. Rev.,* 1937, 44, 1–32.
49. HUNTER, W. S. The disinhibition of experimental extinction in the white rat. *Science,* 1935, 81, 77–78.
50. ——— A curve of experimental extinction in the white rat. *Science,* 1935, 82, 374–376.
51. ——— Conditioning and extinction in the rat. *Brit. J. Psychol.,* General Section, 1935, 25, 135–148.
52. ——— Conditioning and maze learning in the rat. *J. comp. Psychol.,* 1935, 19, 417–424.
53. HURLOCK, E. B. The psychology of incentives. *J. soc. Psychol.,* 1931, 2, 261–290.
54. KARSTEN, A. Psychische Sättigung. *Psychol. Forsch.,* 1928, 10, 142–254.
55. KLEITMAN, N., & CRISLER, G. A quantitative study of the salivary conditioned reflex. *Amer. J. Physiol.,* 1927, 79, 571–614.
56. LEPLEY, W. M. A theory of serial learning and forgetting based upon conditioned reflex principles. *Psychol. Rev.,* 1932, 39, 279–288.
57. ——— Serial reactions considered as conditioned reactions. *Psychol. Monogr.,* 1934, 46, No. 205. Pp. 56.
58. LEUBA, C. J. A preliminary analysis of the nature and effects of incentives. *Psychol. Rev.,* 1930, 37, 429–440.
59. ——— A preliminary experiment to quantify an incentive and its effects. *J. abnorm. and soc. Psychol.,* 1930, 25, 275–288.
60. ——— The measurement of incentives and their effect: a contribution to methodology and orientation resulting from the experimental use of incentives. *J. soc. Psychol.,* 1932, 3, 107–114.
61. LEWIN, K. Environmental forces in child behavior and development. In *A Handbook of Child Psychology,* ed. by C. Murchison. Worcester, Mass.: Clark University Press, 1931. Pp. xii+711 (pp. 94–127).
62. ——— *A dynamic theory of personality,* selected papers. Trans. D. K. Adams and K. E. Zener. New York: McGraw-Hill, 1935. Pp. x+286.
63. ——— *Principles of topological psychology.* New York: McGraw-Hill, 1936.
64. LIDDELL, H. S. The conditioned reflex. In Moss, F. A. (ed.) *Comparative psychology.* New York: Prentice-Hall, 1934, 247–296.
65. LOUCKS, R. B. An appraisal of Pavlov's systematization of behavior from the experimental standpoint. *J. comp. Psychol.,* 1933, 15, 1–47.
66. MCDOUGALL, W. *Psychology, the study of behavior.* London: Williams & Norgate; New York: Holt, 1912. Pp. 254.
67. ——— *Social Psychology.* (13th edition.) Boston: Luce, 1918.
68. ——— Motives in the light of recent discussion. *Mind,* 1920, 29, 277–293.
69. ——— *Outline of psychology.* New York: Scribners, 1923. Pp. xvi+456.
70. ——— Purposive behavior as a fundamental category of psychology. *Sci. Mon.,* 1924, 19, 305–312.
71. ——— The hormic psychology. Chap. 1 in *Psychologies of 1930.* Worcester, Mass.: Clark Univ. Press, 1930. Pp. 3–36.
72. MIKHAÏLOFF, SERGE. Expériences réflexologiques. Experiences nouvelles sur pogurus striatus, Leander xiphias et treilleans. *Bull. de l'Inst.* Oceanogra, 1923, No. 422, 1–16. (Abstracted by Razran, G. H. S., Conditioned Responses in animals other than dogs. *Psychol. Bull.,* 1933, 30, 261–324.)

73. MILLER, N. E. A reply to "Sign-Gestalt or conditioned reflex?" *Psychol. Rev.*, 1935, 42, 280–292.
74. MILLER, N. E., & MILES, W. R. Effect of caffeine on the running speed of hungry, satiated, and frustrated rats. *J. comp. Psychol.*, 1935, 20, 397–412.
75. ——— ——— Alcohol and removal of reward. An analytical study of rodent maze behavior. *J. comp. Psychol.*, 1936, 21, 179–204.
76. MILLER, N. E., & STEVENSON, S. S. Agitated behavior of rats during experimental extinction and a curve of spontaneous recovery. *J. comp. Psychol.*, 1936, 21, 205–231.
77. MITRANO, A. J. The problem of secondary motivation. *Train. Sch. Bull.*, 1936, 32, 165–172.
78. ——— The story of the Woodbine Colony. *Train. Sch. Bull.*, 1936, 33, 1–12.
79. ——— An index to Pavlov's "Conditioned Reflexes" (Anrep translation). Privately printed.
80. PAVLOV, I. P. *Conditioned reflexes: an investigation of the physiological activity of the cerebral cortex* (trans. and ed. by G. V. Anrep). London: Oxford Univ. Press, 1927. Pp. xv+430.
81. PERRIN, F. A. C. The psychology of motivation. *Psychol. Rev.*, 1923, 30, 176–191.
82. PERRIN, F. A. C., & KLEIN, D. B. *Psychology: its methods and principles.* New York: Holt, 1926. Pp. x+387. Chapter IV, The Motivation of Behavior, 132–195.
83. PORTER, J. M., JR. Temporal factors in experimental extinction. Ph.D. thesis, 1936. Yale Univ.
84. RAZRAN, G. H. S. Theory of conditioning and related phenomena. *Psych. Rev.*, 1930, 37, 25–43.
85. ——— Conditioned responses in animals other than dogs. *Psychol. Bull.*, 1933, 30, 261–324.
86. ——— Conditioned responses in children. *Arch. Psychol.*, 1933, 23, No. 148, 3–120.
87. ——— The conditioning of voluntary reactions. *J. exp. Psychol.*, 1936, 19, 653–654.
88. REYNOLDS, H. E. The disinhibiting effect of an electric shock upon the maze performance of the white rat. *J. comp. Psychol.*, 1936, 22, 187–197.
89. REXROAD, C. N. An examination of the conditioned reflex theory. *Psychol. Rev.*, 1933, 40, 457–466.
90. ——— Goal-objects, purposes, and behavior. *Psychol. Rev.*, 1933, 40, 271–281.
91. ——— Reaction time and conditioning: First studies. *J. exp. Psychol.*, 1936, 19, 144–158.
92. ROBINSON, E. S. *Association theory to-day.* New York: Century, 1931.
93. RODNICK, E. H. Characteristics of delayed and trace conditioned responses. *J. exp. Psychol.*, 1937, 20, 409–425.
94. SHIPLEY, W. C. A comparative study of the rate of experimental extinction in conditioned reflexes. M.A. thesis, 1929. Univ. Wis.
95. ——— An apparent transfer of conditioning. *J. gen. Psychol.*, 1933, 8, 382–391.
96. ——— Studies of inhibition in conditioned responses. *J. gen. Psychol.*, 1934, 11, 46–64.
97. ——— Indirect conditioning. *J. gen. Psychol.*, 1935, 12, 337–357.

98. SKINNER, B. F. On the conditions of elicitation of certain eating reflexes. *Proc. nat. Acad. Sci.*, 1930, 16, 433–438.
99. ——— Drive and reflex strength: I and II. *J. gen. Psychol.*, 1932, 6, 22–48.
100. ——— The concept of the reflex in the description of behavior. *J. gen. Psychol.*, 1932, 6, 22–37, 38–48.
101. ——— On the rate of formation of a conditioned reflex. *J. gen. Psychol.*, 1932, 7, 274–286.
102. ——— On the rate of extinction of a conditioned reflex. *J. gen. Psychol.*, 1933, 8, 114–129.
103. ——— "Resistance to extinction" in the process of conditioning. *J. gen. Psychol.*, 1933, 9, 420–429.
104. ——— The extinction of chained reflexes. *Proc. nat. Acad. Sci.*, 1934, 20, 234–237.
105. ——— The generic nature of the concepts of stimulus and response. *J. gen. Psychol.*, 1935, 12, 40–65.
106. ——— Two types of conditioned reflexes and a pseudo-type. *J. gen. Psychol.*, 1935, 12, 66–77.
107. ——— A discrimination based upon a change in the properties of a stimulus. *J. gen. Psychol.*, 1935, 12, 313–336.
108. ——— A failure to obtain "disinhibition." *J. gen. Psychol.*, 1936, 14, 127–135.
109. ——— Conditioning and extinction and their relation to drive. *J. gen. Psychol.*, 1936, 14, 296–317.
110. STONE, C. P. Motivation: incentives and drives. In *Comparative Psychology, ed. by F. A. Moss.* New York: Prentice-Hall, 1934. Pp. 73–109.
111. SWITZER, S. A. Backward conditioning of the lid reflex. *J. exp. Psychol.*, 1930, 13, 76–97.
112. ——— Disinhibition of the conditioned galvanic skin response. *J. gen. Psychol.*, 1933, 9, 77–100.
113. ——— Anticipatory and inhibitory characteristics of delayed conditioned reactions. *J. exp. Psychol.*, 1934, 17, 603–620.
114. ——— The effect of caffeine on experimental extinction of conditioned reactions. *J. gen. Psychol.*, 1935, 12, 78–94.
115. THORNDIKE, E. L. Animal intelligence. *Psychol. Monogr.*, 1898, 2, No. 8. Pp. 109.
116. ——— *The fundamentals of learning.* New York: Teachers College, Columbia University, 1932.
117. ——— *The psychology of wants, interests, and attitudes.* New York: Appleton-Century, 1934. Pp. x+301.
118. TOLMAN, E. C. *Purposive behavior in animals and men.* New York: Century Company, 1932. Pp. xiv+322.
119. ——— Conditioned reflex or sign-Gestalt. *Psychol. Rev.*, 1933, 40, 246–255.
120. TOLMAN, E. C., HALL, C. S., & BRETNALL, E. P. A disproof of the law of effect and a substitution of the laws of emphasis, motivation and disruption. *J. exp. Psychol.*, 1932, 15, 601–614.
121. TROLAND, L. T. *The fundamentals of human motivation.* New York: Van Nostrand, 1928. Pp. xiv+521.
122. ——— Motivational psychology. In *Psychologies of 1930* (ed. by C. Murchison). Worcester, Mass.: Clark Univ. Press, 1930. Pp. 460–480.

123. WARDEN, C. J., WARNER, L. H., and others. *Animal motivation: experimental studies on the albino rat.* New York: Columbia University Press, 1931. Pp. xii+502.
124. WENDT, G. R. An analytical study of the conditioned knee-jerk. *Arch. Psychol.*, 1930, 19, No. 123.
125. WENDT, G. R. An interpretation of inhibition of conditioned reflexes as competition between reaction systems. *Psychol. Bull.*, 1934, 31, 730–731.
126. WENGER, M. A. External inhibition and disinhibition produced by duplicate stimuli. *Amer. J. Psychol.*, 1936, 48, 446–456.
127. WHITE, R. K. The completion hypothesis and reinforcement. *Psychol. Rev.*, 1936, 43, 396–404.
128. WILLIAMS, K. A. The reward value of a conditioned stimulus. *Univ. Calif. Publ. Psychol.*, 1929, 4, No. 3, 31–55.
129. WINSOR, A. L. Inhibition and learning. *Psychol. Rev.*, 1929, 36, 389–401.
130. WOLFE, J. B. Effectiveness of token rewards for chimpanzees. *Comp. Psychol. Monogr.*, 1936, 12, No. 12. Pp. 72.
131. WOODWORTH, R. S. *Dynamic psychology.* New York: Columbia Univ. Press, 1918. Pp. 210.
132. ——— Dynamic psychology. Chap. 5 in *Psychologies of 1925.* Worcester, Mass.: Clark Univ. Press, 1926. Pp. 111–126.
133. ——— Dynamic psychology. Chap. 17 in *Psychologies of 1930* (ed. by C. Murchison). Worcester, Mass.: Clark Univ. Press, 1930. Pp. 327–336.
134. YOUNG, P. T. *Motivation of behavior.* New York: Wiley, 1936. Pp. xviii+562.
135. YOUTZ, R. E. P. Reinforcement, extinction, and spontaneous recovery in a non-Pavlovian reaction. *J. exp. Psychol.*, 1938, 22, 305–318.
136. ——— The change with time of a Thorndikian response in the rat. *J. exp. Psychol.*, 1938, 23, 128–140.